Graphicacy within the secondary school curriculum, an exploration of continuity and progression of graphicacy in children aged 11 to 15

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GRAPHICACY WITHIN THE SECONDARY SCHOOL CURRICULUM, AN EXPLORATION OF CONTINUITY AND PROGRESSION OF GRAPHICACY IN CHILDREN AGED 11 TO 15

BY

XENIA DANOS BA (Hons.)

A doctoral Thesis
Submitted in partial fulfilment of the requirements for the award of

Doctor of Philosophy
of Loughborough University

(11 July 2011)

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ABSTRACT

Ph. D

GRAPHICACY WITHIN THE SECONDARY SCHOOL CURRICULUM, AN EXPLORATION OF CONTINUITY AND PROGRESSION OF GRAPHICACY IN CHILDREN AGED 11 TO 15

Xenia Danos

Graphicacy is the fundamental human capability of communicating through still images. Graphicacy has been described as the ‘fourth ace’ within education, alongside literacy, numeracy and articulacy. However, it has been neglected, both within education and the research field. This thesis investigates graphicacy and students’ learning, structured around 3 objectives: establishing what graphicacy is and how it is used in the school curriculum; demonstrating the wider significance of design and technology teaching and learning by collecting evidence of the importance of graphicacy across the curriculum; and establishing how the abilities to understand and create images affect students’ learning.

A literature review was conducted focused on three areas. Firstly, identifying the meaning of graphicacy, elements contained within it and relevant prior studies including its use in different subject areas and image use within teaching. This formed the foundations for a new taxonomy of graphicacy. Secondly, the levels of drawing and developmental stages children go through were investigated and the need for further research on children’s abilities aged 11 to 14 was identified. The well balanced arguments concerning the nature versus nurture debates are described. Thirdly, the methodology used to measure graphicacy, and map the results to reflect levels of different competencies were reviewed.

A naturalistic and often opportunistic approach was followed in this research. The research methodology was based on the analysis of textbooks and later, on research within practice. The research included the development, validation and use of the taxonomy of graphicacy; case studies in Cyprus, the USA and England on identifying graphicacy use across the curriculum; and the creation of continuity and progression descriptors through the analysis of students’ work. This work covered: rendering, perspective drawing, logo designing, portrait drawing and star profile charts. Research methodologies developed and implemented for conducting co-research and the Delphi studies are also described.

Through interviews with experts, the taxonomy was validated as an appropriate research tool to enable the identification of graphicacy use across the curriculum. These research studies identified links between design and technology and all other subject-areas studied. Similar patterns of graphicacy use were identified across 3 schools, one in Cyprus, USA and the UK. Photographs were the most commonly used graphicacy element across all subject areas studied. Design and technology within England was found to use the widest variety of graphicacy elements, providing evidence towards research objective 3; establishing how the ability to understand and create images affects students’ learning. Continuity and progression (CaP) descriptors were created for each area covered by this research. The success of the CaP descriptors relied on the technical complexity involved in the creation of each image. Some evidence was found concerning the limits of natural development and how nurture can further develop graphicacy skills. In addition, co-research as a methodology, its limitations and potentials are identified.

Keywords: Graphicacy, communication, continuity and progression, descriptors, assessment, learning, image use, pedagogy, cross-curricular, links.
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CHAPTER ONE

Introduction

Introduction of Chapter 1

In this chapter the area of research is introduced and a discussion is provided explaining the need for new knowledge in this area. In section 1.1 this author’s professional background and motivations are expressed. The chosen area of study, graphicacy, is introduced. The main focus lies on its current status, both within our culture but more specifically within secondary education. Connections between subject specific taught skills and everyday work-related skills are illustrated in section 1.2. Section 1.3 discusses this author’s relevant prior expertise regarding the chosen area of research. Future benefits are described and justifications for the age group chosen are provided. The aims and objectives of this research are developed into research questions, which are focusing on dealing with the above issues, are presented in section 1.4. These are then illustrated through a research summary table in section 1.5.
1.1 Research background

Graphicacy is the ability to communicate through still visual images such as graphs, maps, diagrams, symbols and drawings. Graphicity and the pedagogy associated with the skills, abilities and education of continuity and progression are the main areas of focus for this research. Graphicacy is also known as visual literacy (commonly used in the USA) and pictorial capability (commonly used in Sweden). The word graphicacy is primarily used in this text following the cultural and education context of this study’s focus.

1.1.1 Personal motivations

Education aims to offer new knowledge, build on existing knowledge, and help each individual to progress and develop academically. To achieve that, clear goals, aims, targets and a clear understanding of the path required to be followed are essential. These are not, however, always found in curriculum documents. An example of this can be found in design and technology curriculum documents (Norman, 1997); a key subject area in teaching graphicacy. In the UK schools’ curriculum provision, we find literacy, numeracy and articulacy being the main focus areas across the subjects, placing no substantial focus on graphicacy. However, in all subjects, lessons are primarily taught with the use of verbal and visual communication. Despite this, the teaching of understanding and working with different types of images takes up only a minimum time of the curriculum.

Furthermore, the National Curriculum in England at the moment offers vague level descriptions in relation to skills in different elements of graphicacy. This often confuses educators, especially art and design and technology teachers, when dealing with graphicacy. They are often advised to approve all children’s work in order to avoid discouraging further effort, but not to praise work unless it is up to the standard for the age level. This is a longstanding problem which has been going on at least since the 1970s. Rhoda Kellogg identified this problem, and commented that ‘…nowhere are age level standards defined in a way that is both objective and usable in an ordinary classroom. Thus each teacher’s personal taste actually becomes the final measure of age-level achievement’ (Kellogg 1970:152). Since then, there has not been much significant improvement made in this area. This author believes that once continuity and progression has been determined and clearly presented, graphicacy can consciously be taught and nurtured to reach new achievement levels. Contributing towards this aim is the essential target of this PhD research.

1.1.2 Status and value of graphicacy within education

Visual communication is the creative development and conveyance of ideas and information in forms that can either be read or looked upon. The skill required for dealing with visual
communication is ‘Graphically’. The power of images has great possibilities and potentials. It can break through the barriers of language and academic status; it can change one’s perception and decisions. It can be used as a tool for learning and for recording thinking. This is a message which has to be clearly communicated and demonstrated to educationalists. ‘At a time when (all of us) are exposed to more media messages than ever before, young people in part are given no guidance on how to read, interpret and critically evaluate the images and information they are exposed to. ‘This renders them visually vulnerable and potential victims of a language that can influence and manipulate them’ (Considine, 1987:635).

Currently graphicacy does not explicitly feature within the structured curricula in England; a situation that is similar in many other countries within Europe, the US and Australia, among others. Educationalist are often advised to use visual images as teaching aids, yet we know very little about how these are perceived by children with different abilities. This research is aimed at identifying and defining graphicacy, investigating its significance in the curriculum, exploring how children deal with it and ultimately how it can affect their learning. A range of terms exist today to describe the ability to communicate through pictures and images. Two terms in common usage are ‘visual communication’ and ‘visual literacy’, and more specific terms like ‘cartography’ and ‘drawing’ are used to describe particular elements of graphicacy. Past research has highlighted the importance of visual communication in a variety of subjects, including the sciences, mathematics, geography and art and design. The term ‘graphically’, was first introduced in geography to describe the skills required to read and understand maps. Mathematicians have also used it for the ability to deal with mathematical graphs and charts.

1.1.3 Teaching in art & design and design & technology

While teaching graphicacy skills through the lessons of art & design and design & technology, everyday observations suggested that all students could potentially learn how to create images to high standards. Specific teaching and learning is required for each type of image, which could enable even the ‘non-artistic’ children to read and understand and even create images deemed as ‘complex’ for the specific student and/or age range. Through strategically designed teaching methods, most students are able to improve their skills and abilities, which can also improve other areas of study through cross-curricular links e.g. mathematics and science, through teaching and learning of one and two point perspective drawing, using scale, perspective as perceived by the human eye etc.

This research is aims to explore the following:
- Can we identify continuity and progression of various elements of graphicacy?
- Are there levels that children reach naturally?
- Are there specific stages children go through?
- Can children reach a higher understanding through nurture?
- What are the full potential children can reach through nurture?
• Which elements are nurtured through design & technology and art & design?
• Are there cross curricular links between the ways images are used?
• Which subject areas benefit from the graphicacy knowledge children gain during design & technology and art & design?
• Can we prove the importance of design & technology and art & design through identifying cross curricula links?
1.2 Identifying graphicacy in everyday life

1.2.1 The importance of graphicacy

Graphic communication is universal. ‘Making and interpreting marks is fundamental to all peoples and cultures. Drawing is extraordinarily versatile and has a huge repertoire of forms and uses. It is an intellectual activity that links sensing, feeling, thinking and doing’ (Baynes, 2008).

The characters of the alphabet were first created as pictures with meanings (West, 1997). At that time, images and letters had no distinction; hence literacy and graphicacy were merged into one. Constructing a sentence was merely a sequence of images placed in an order. When the printing press emerged, illustrations and text got divided, and the weight shifted towards a heavy-text approach. Recently, this balance has started to change with the use of various ways of presenting and representing data, ideas and information. Sophisticated computer software programmes have the capability to visually represent complex data and ideas, helping to understand and grab incomprehensible, until now, concepts. To be an effective communicator today, numeracy and literacy proficiency is insufficient. Additional skills in graphicacy and the emerging technologies are required (Stokes 2002).

Graphic images have the ability to catch our attention. They can rapidly communicate relative values, quantitative comparisons and numerical trends. Since graphic images can illustrate spatial patterns, they can allow connections to be captured, recognised and quickly analysed. Graphic visualisation stimulates conceptualisation and integrative thinking, i.e. the representation of the complex structure of DNA (Poracsky J., Young E., Patton J. P., 1999). ‘There are certain core aspects of future reality which cannot effectively be modelled in language or number’ such as colour, space, shape, distance and scale amongst others (Baynes, 2011:4).

1.2.2 Graphicacy for people from all walks of life

When Baynes (2008) asked people from different professions the question ‘why draw?’ these were the key reasons given:

- it is an essential part of the work of imagining;
- to construct and manage production;
- to explore ideas;
- to communicate key points to other people;
- to highlight features;
- to set out a structure;
- to support calculations for technical details;
- for planning and organising.
In a world where information is often technical and time is often short, visual images potentially offer a direct, fast, effective and efficient way of communicating. Internet websites often use images and animations to support or bring forward messages. Consequently, as a society and as the growth of the use of the Internet continues, we are becoming ever more dependent on visual images.

Baynes gave a rich list consisting of 107 professions (Table 1.1) in an inventory of some of the people who use images and drawings in their work. In addition, analysis of his work (Quick on the Draw exhibition, 2008), revealed 26 further professions. Table 1.1 illustrates these 133 professions, having in bold some of the ones perhaps least expected to be using images.

| Some of the people who use drawing in their work taken from the Quick on the Draw exhibition |

Table 1.1 Professions who use drawings identified in the Quick on the Draw exhibition (Baynes, 2008)
1.3 Prior expertise

1.3.1 Prior expertise appropriate for this research

Teaching in a school serving a middle class catchment area meant that students were expected to be motivated and guided to achieve the best they could at all times. If homework or class-work did not reflect each students’ true potentials, individual thorough feedback was given in writing and verbally with detailed step-by-step guidance on how to reach each next level of competency/achievement. This was followed through by this author as their teacher, for most pieces of work, until I was satisfied that the student had reach their full potential. As an experience this was very valuable to me, as it taught me to distinguish and verbalise progression stages for each individual piece of work I gave feedback on. It also made it clear that even the ‘non-artistic’ students were able to achieve very high marks on homework based heavily on drawing and other types of images.

During that time, I was also teaching art & design for Key Stage 3 (ages 11-14). As my background was based mostly on technical types of drawings, I had to learn the correct way of creating certain types of images before I could teach them, i.e. drawing portraits, detailed observational drawing and one and two point perspective drawing of urban landscape. While trying to teach myself how to create these images, I realised how difficult it was to learn these skills by following written instructions or other experts. Even if each stage was followed to the letter, the drawings still did not look exactly ‘right’. It was then I realised how vague instructions can be when one is learning something for the first time. Often the instructions are written by experts, where a lot of important information is regarded as ‘common sense’. Often important details are not recognised and do not have attention drawn to them, like for example the direction light is reflected from the surface of a certain shaped object. Through trial and error I was able to identify the ‘missing stages’ and successfully create the type of images I was dealing with each time. Once that was done, teaching the students how to recreate such an image was easy and straightforward both to me and my students. It made a significant difference to the ‘less able’ students, who often started a drawing task by expressing how they thought ‘they could not draw’ and ended up creating ‘their best work so far’.

Placing a lot of importance on assessing for learning during my teaching years, and having to so often deal with vague assessment descriptions, made me realise the importance of this research as well as potential outcomes. It also brought up the following research questions:

- How wide is the scope and use of graphicacy? What does it cover/include?
- How can learning and teaching in one area (e.g. design & technology) affect the learning and teaching in another (e.g., trigonometry in mathematics)?
- What are the basic graphicacy skills of UK students in years 7, 8 and 9 (aged 11-14)?
- What are the true potentials and limitations in graphicacy skills of UK students in years 7, 8 and 9 (aged 11-14)?
If graphicacy was nurtured as much as literacy and numeracy, how far could Key Stage 3 (KS3) students reach after 3 years?

Following on from this prior experience, during the PhD I had to gain new knowledge and understanding on a variety of areas in order for me to answer some of the above questions. These included: cognitive, psychological and artistic development and progression of children, cross-curricular links, visual understanding, types of images and their complexity, how these are taught and their use across the curriculum etc. I have also had the opportunity to practise different ways of teaching and have acquired advanced skills in creating teaching resources, inclusive of students with different abilities and needs.

1.3.2 Future benefits

The research articulates continuity and progression in different graphicacy areas, which is found to be a cross-curricular issue. This enables more effective teaching and support for all students, including students with learning difficulties, less able, non-artistic, gifted and talented. Consequently it could support initial teacher training for those about to enter the profession in creating inclusive teaching tasks, as well as contributing to CPD (continued professional development) programmes.

1.3.3 Age group focus

Extensive experience and understanding of secondary school students’ abilities were already in place due to the author’s prior experiences. This also included knowledge of the levels of understanding required for design & technology and art & design in a number of areas in the English National Curriculum, including but not limited to drawing. The choice between dealing with KS3 (ages 10/11-13/14) and/or KS4 (ages 14/15-17/18) students was made based on the information found through the literature review. Detailed understanding on continuity and progression was found for children aged up to 8 or 9. The next natural stage seemed to be the gaining of understanding for the lower years within secondary education.

1.3.4. Cultural influences undervaluing graphicacy

Despite the wide-spread use of graphicacy in UK schools, graphicacy as a communication skill has yet to be recognised. There are established policies recognising the importance of literacy and numeracy and incorporating these across the curriculum, whereas graphicacy has been long overlooked. This attitude is also adopted by the students, who take example from the adults around them. There is a tendency to regard artists as academically and economically unsuccessful i.e. low ability, ‘starving artists’. Literacy and numeracy, on the other hand, are
associated with successful academic careers such as medicine and law. In order for graphicacy to be properly developed, that kind of cultural position needs to be redressed.
1.4 Summary of research program

1.4.1 Aims and objectives

The aim of the research is to map graphicacy across the English secondary school curriculum, understand its purposes and its effects on students' learning.

The focus of the study is on graphicacy at KS3 and the type of knowledge and information the images are associated with. The final focus of the study is on the outgoing (creating an image) skills and abilities of graphicacy at KS3 levels. Initially the research will analyse the incoming (reading and understanding an image) information communicated through images (or otherwise referred to as ‘elements of graphicacy’ through this report), focusing primarily on textbooks and supported by interviews with teachers. The main purposes of the types of images use, across the curricula will be determined.

The research aims to identify, define and categorise the skills and abilities required when dealing with outgoing skills (creating visual images) and to support and show understanding in key elements of graphicacy directly relevant to design & technology education. The research aspired to identify and measure graphicacy continuity and progression through collection and analysis of students’ work. The final goal of this research is to understand graphicacy as communication ability and produce descriptors of continuity and progression which could support the development of appropriate pedagogy.

- Objective 1: To establish what graphicacy is and how it is used in the school curriculum.

The first step is to establish the meaning of graphicacy. Literature review, talking with experts in the field and sharing information with teachers, will form the initial steps to clarify this. Existing information on measuring graphicacy continuity and progression descriptors will be sought. Confirmation that graphicacy is used in the school curricula will follow, by analysis of school textbooks and interviewing teachers. Looking at the UK secondary school curricula should provide evidence towards the nature of graphicacy; towards identifying if graphicacy is a basic human skill or a cultural behaviour. This research will extend to Cyprus, the USA and the UK. The outcomes should provide the foundations for the evidence, existence and of the analysis of graphicacy within secondary education.
- **Objective 2:** To demonstrate the wider significance of design & technology teaching and learning by collecting evidence of the importance of graphicacy across the curriculum.

The types of images used in outgoing graphicacy skills will be categorised, and plotted against the types of images used in design & technology. This will be conducted with a number of subject areas and comparisons between them will provide evidence relating to the above statement.

- **Objective 3:** To establish how the abilities to understand and create images affect students’ learning abilities.

The research will focus on whether children go through a sequence or a set of stages regarding various graphicacy elements. A search will be made acquiring an understanding of the development of graphicacy children go through naturally. If information on this matter exists, then the skills and abilities needed to understand and create graphicacy elements (images) will be identified, for various competencies. Tasks will be developed to measure students’ continuity and progression descriptors in particular areas of graphicacy. These will be matched with required cross-curricular skills in order to identify how fundamental graphicacy is to students’ progress. The goal of this study is to produce descriptors of educational continuity and progression of graphicacy for KS3.

**1.4.2 Research questions**

The study will begin by identifying where and how graphicacy is used in secondary schools’ curriculum programmes, what the requirements, skills and abilities are to be able to communicate graphically and how these can affect students’ learning.

Research questions related to Objective 1: ‘Establish what graphicacy is and how it is used in the school curriculum’.

1. What is graphicacy?
2. Has graphicacy across the curriculum been studied before? If so, what were the findings?
3. How can we measure graphicacy?
4. Are there existing ‘graphicacy tests’ or tests based on the skills of creating images?
Research questions related to Objective 2: ‘Demonstrate the wider significance of design & technology teaching and learning by collecting evidence of the importance of graphicy across the curriculum’.

5. Where does graphicy fit across the curriculum?
6. How does graphicy appear in ‘teaching’ (within the sample of schools and subjects studied)?
7. What are the main similarities of the use of images across different subjects?

Research questions related to Objective 3: ‘Establish how the abilities to understand and create images affect students’ learning’.

8. Are there established methods for studying graphicy within the curriculum?
9. Are there main stages/levels of drawing, mark making or other graphicy related abilities that children go through?
10. How does graphicy capability change/develop during the years of 11-14 years?
11. How fundamental is graphicy to students’ progress?
12. Is the potential offered by graphicy fully exploited for the learning of all students?
13. Can co-research provide useful data for this research?

1.4.3 Data collection strategy

Table 1.2 shows the research questions and the associated data collection methods. The information collected for each question, where possible, is verified by a minimum of three sources. More information on why each method was chosen to answer each question is provided in Chapter 5.
Table 1.2 Data collection methods

<table>
<thead>
<tr>
<th>Questions</th>
<th>Literature review</th>
<th>Interviews</th>
<th>Observations</th>
<th>Case studies</th>
<th>Curriculum analysis</th>
<th>Analysis of textbooks</th>
<th>Co-research</th>
<th>Delphi study</th>
<th>Presentations (Appendix 1)</th>
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<tbody>
<tr>
<td>1. What is graphicity?</td>
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<td>6. How does graphicity appear in ‘teaching’ (within the sample of schools and subjects studied)?</td>
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<td>7. What are the main similarities of the use of images across different subjects?</td>
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<td>8. Are there established methods for studying graphicity within the curriculum?</td>
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<td>9. Are there main stages/levels of drawing, mark making or other graphicity related abilities that children go through?</td>
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<td>10. How does graphicity capability change/develop during the years of 10-15 years?</td>
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<td>11. How fundamental is graphicity to students’ progress?</td>
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<td>12. Is the potential offered by graphicity fully exploited for the learning of all students?</td>
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<td>13. Can co-research provide useful data for this research?</td>
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Chapter One: Introduction

1.5 Summary of Chapter 1

Chapter 1 provides an overview of the research area. Prior experience in teaching graphicacy has been acknowledged as a primary motivation for working on graphicacy. Furthermore, the importance of graphicacy within the curriculum and later on in the professional work life has been identified. An introduction into graphicacy is given along with its current status, issues and existing related problems. Graphicacy is now, more than ever, widely used, and an effort will be made for it to be recognised in a similar way as literacy and numeracy currently are. The specific age range of children 11 to 14 (KS3) has been identified as the focus group for this study. A summary of the research programme provides the aims, objectives, research questions and possible data gathering methods for this study.
CHAPTER TWO

A literature review (part 1)

Graphicacy: definitions, descriptions and cross-curricular issues

Introduction to chapter 2

In section 2.1 the literature review research methodology is described. The key words and search engines used to collect the information reviewed in this chapter are listed. A short description of the process followed to select the relevant literature is also provided. In section 2.2 the meaning of graphicacy is explained. Definitions of graphicacy, or otherwise known as visual literacy, are given by a number of authors. The international emergence of graphicacy in the UK, USA, South Africa and Australia is described in section 2.3. Typologies of graphicacy and an existing taxonomy are also described. Section 2.4 is focused on prior studies of graphicacy from a range of different perspectives. These are presented and categorised within a range of subject areas and disciplines. Furthermore, different authors’ work is reported on aspects relating to how useful or not visual literacy can be during teaching and learning. The final section, 2.5 gives a summary of this chapter and the plans for the next steps are discussed.
2.1 Literature review research methodology

The key words used for the online searches are shown in Table 2.1. They were chosen to access the areas related to the following research questions: research questions 1 (RQ1) what is graphicacy? RQ2 has graphicacy across the curriculum been studied before? If so, what were the findings? RQ5 where does graphicacy fit across the curriculum? RQ6 how does graphicacy appear in ‘teaching’? Table 2.2 shows the list of search engines initially explored.

<table>
<thead>
<tr>
<th>Key words</th>
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<tr>
<td>Graphicacy, visual literacy, visual communication, images in/for teaching, images in/for learning, use of images, types of images, image use in mathematics/ DT/ art/ history/ geography/ music/ ICT/ RE/ PE/ science/ physics/ chemistry/ biology, Taxonomy of images, visual stimulus, visual literacy, visual perception, graphicacy, critical graphicacy, visual thinking, creative growth, mental growth, visual communication</td>
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Table 2.1 Key words used in the online searches for the literature reviewed in this chapter

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The initial results from the above key words when used individually in general search engines such as www.amazon.com and http://scholar.google.co.uk provided millions of results (7,160,000). Once two words were included in the same search, results began narrowing down to approximately 2,500,000. More specialised search engines were then used such as MetaLib and MyAthens, which brought results down to a few 100s per key word search. Approximately 850 – 1,000 papers and books were shortlisted through the above process. The summary of each paper was reviewed online. The material which seemed relevant to this study was then obtained. Approximately 350 sources have been used to build the literature review for this study.

These sources were classified according to the information they provided, i.e.:

- Identifying the meaning of graphicacy
- Prior research on graphicacy or visual communication
- Tests for graphicacy and related competences
- General human developmental stages including human perception
- Visual communication and drawing developmental stages
2.2 What is graphicacy

In the 1980s the UK Associated Examining Board described graphicacy as all forms of diagrammatic presentation used to communicate information that cannot be conveyed clearly and conveniently by words or mathematical notation alone. Around the same time, other authors supported a similar view, saying that to be graphicate is a fundamental human ability in the same way as to be literate, numerate and articulate. Drawing should not be seen only as a piece of artwork but as an aid to understanding communication, ideation and problem solving processes (Krane & Dyson, 1981; Postman, 1979).

A range of definitions exist today to describe the ability to communicate through pictures and images. Some of the most common definitions used today are ‘visual communication’ and ‘visual literacy’. A range of terms are also widely used to describe some elements of graphicacy. These include ‘cartography’ and ‘drawing’.

Graphicacy is the ability to understand, read and create still visual images other than words/letters or numbers, as a means of communication. These can include maps, diagrams, drawings and flow diagrams, amongst others. It is argued that literacy, numeracy, oracy and graphicacy are the ‘four aces’ in the pack of education. If any one of these is left out of the pack, education is incomplete (Balchin & Coleman, 1965:85; Harmelen, 2002). Balchin refers to graphicacy as the first type of communication to evolve between human beings, with the beginning of highly civilised skills such as map-reading and spatial planning (Balchin, 1976).

Wileman (1993:114) defines visual literacy as ‘the ability to read, interpret, and understand information presented in pictorial or graphic images’. Associated with visual literacy is visual thinking, described as ‘the ability to turn information of all types into pictures, graphics, or forms that help communicate the information’. A similar definition for visual literacy is ‘the learned ability to interpret visual messages accurately and to create such messages’ (Heinich et al. 1999:64). The ERIC definition of visual literacy is ‘a group of competencies that allows humans to discriminate and interpret the visible action, objects, and/or symbols, natural or constructed, that they encounter in the environment’. Robinson (as cited in Sinatra, 1986:v) describes visual literacy as ‘an organizing force in promoting understanding, retention, and recall of so many academic concepts with which students must contend’. Sinatra (1986:5) defines visual literacy as the active reconstruction of past visual experience with incoming visual messages to obtain meaning, with the emphasis on the action by the learner to create recognition. The use and interpretation of images is a specific language in the sense that images are used to communicate messages that must be decoded in order to have meaning (Branton, 1999; Emery & Flood, 1998). If visual literacy is regarded as a language, then there is a need to know how to communicate using this language, which includes being alert to visual messages and critically reading or viewing images as the language of the messages.
Visual literacy, like language literacy, is culturally specific although there are universal symbols or visual images that are globally understood (Sinatra, 1986:12-13).

Fry stated that ‘reading and comprehending graphs is only half the graphical literacy. The other half is the ability to draw them’ (Fry, 1981:388). Stokes refers to that as the ability ‘to interpret images’ as well as ‘to generate’ images for communicating ideas and concepts (2002:10). The ability to read and understand images is also often referred to as ‘inbound’ or ‘incoming’. The ability to create images is sometimes referred to as ‘outbound’ or ‘outgoing’ (Balchin, 1976; Wilmot, 1999; Balchin & Coleman, 1965). Wilmot realised graphicacy was a complex form of communication in that it utilises some form of symbolic language to convey information about spatial relationships (Wilmot 2002:326). She calls graphicacy a ‘tool’ through the use of which we are able to ‘communicate and share our spatial knowledge with others’ (339). Boardman shared a similar belief, and stated that ‘graphicacy, which complements literacy, numeracy and oracy as a means of communication, describes the way in which spatial information is communicated other than by words or numbers alone’ (Boardman, 1990).

Fisher also talks about spatial development, which can be considered as elements of graphicacy, and describes it as the capacity to perceive the visual world accurately and to recreate visual experience in the ‘mind’s eye’ (Fisher, 1990). Harmelen (2002:3) gives a similar but much simpler definition, describing it as our ability to navigate in our space. Turbayne (1970) identified three basic steps in the process of perception when dealing with visual literacy: selection, organisation and interpretation of stimuli. Frame of reference is an additional active factor which can be added to Turbayne’s list.
2.3 The international emergence of graphicacy

Research into graphicacy, or visual literacy, has emerged in a number of countries around the world. The conceptual history seems to lead to at least two primary starting points: the work of Balchin and his colleagues in the UK in the 1960s and the work of Fry in the USA in the 1970s. These are described below, as well as the developments in South Africa and Australia being noted as examples of graphicacy’s wider reach.

2.3.1 Graphicacy in the UK
The general term used for communicating through visual images in the UK is ‘Graphicacy’. The word graphicacy has emerged as a natural development to stand ‘next to literacy, articulacy and numeracy’ (e.g. Balchin, 1976:85) which can be considered as the basic skills which underpin our school curricula.

When the word graphicacy first appeared in the mid-1960s in a journal paper published by Balchin and Coleman (1965), it was presented in a geography context. Balchin later defined graphicacy as ‘the communication of spatial information that cannot be conveyed adequately by verbal or numerical means alone’ (1985:8). The term struck a strong resonance and influenced academics both in the UK and other countries, across a range of subject areas.

2.3.2 Graphicacy in the USA
In New Jersey, Fry (1974) talked about ‘literacy in graphs which was beginning to approach word literacy’ (383). He used the term ‘graphical literacy’ to describe ‘the ability to read and write (or draw) graphs’, and defined a graph as ‘a two dimensional visual representation of a concept in a nonverbal or at most partly verbal form’ (390). ‘The bar graph’ and the ‘time line’ (387) were given as examples. Supported by the view that ‘pictures, maps and other types of graphs have been used throughout the ages, since or before written verbal language (383)’, he proposed that ‘reading teachers are well equipped to take active educational leadership in graphical literacy because they already have many skills that are readily transferable’ (385). He suggested that study skills instruction should include not just the reading and writing of graphs, but the fact that a prime study technique is to translate a verbal passage into a graph. He suggested that a taxonomy such as his could have another important curriculum-related function. It can serve as the basis of achievement tests. Furthermore, the taxonomy could be useful to students and practitioners in various fields outside of education, such as advertising, journalism, television, computer programming and business report writing. Or in any case where someone received or sent two-dimensional visual information (1980).
Taking a similar view and using parallel examples, Tierney et al. from Boston, in 1990 wrote; ‘graphical literacy’ is defined as the ability to interpret charts, maps, graphic, and other pictorial presentations used to supplement the prose in textbooks, non-fiction trade books and newspapers. Aldrich and Sheppard (2000) included a more extensive list of some of the forms of images included in graphicacy, which have been represented in Figure 2.1.

![Forms of images included in Graphacy](image)

*Figure 2.1 An illustration of some of the forms of images included in graphicacy taken from Aldrich and Sheppard (2000)*

### 2.3.3 Graphicacy in South Africa

In South Africa, Wilmot completed research work in the mid-1990s, which was strongly influenced by the work of Balchin and Coleman, amongst others. Wilmot's work at the time was focused on graphicacy and primary school children, and it became very influential on the design of the South African educational system at that point in time. Graphicacy was incorporated into the primary school curricula as one of the four basic skills children should be taught, along with literacy, numeracy and articulacy. In her report Wilmot (2002) describes graphicacy as ‘a complex form of communication in that it utilizes some form of symbolic language to convey information about spatial relationships’. Van Harmelen, who worked closely with Wilmot for some time, took a geography perspective on the topic (influenced by
Balchin) and suggested that ‘graphicacy is the language the geographers use for the form of communication concerning space, place and time’ (2002:5).

2.3.4 Graphicacy in Australia
Another view taken around this area was from the Senate Standing Committee on Education and the Arts in Australia (1981:48). It was said that ‘non-verbal communication is equally a fundamental part in social life, as visual learning directs students toward an understanding and appraisal of the mass media’. They talked about integrating visual learning in the school curriculum as they believe visual competence is necessary in many school subjects.

2.3.5 Graphicacy in Ireland
Ireland has a long tradition of graphical education, which has typically been associated with vocational education. This history has only recently been documented by Seery et al. (2001), and this indicates that at least in recent decades, there have been more general educational objectives. Graphicacy was first acknowledged and intentionally included within the syllabus of the Irish NCCA (National Council for Curriculum and Assessment) in 1991, through a course entitled ‘Technical Graphics’. The course was introduced to replace the previously vocational course of ‘Mechanical Drawing’.

‘Technical graphics proposed the “development of the cognitive and practical manipulative skills associated with graphicacy and to stimulate the pupils’ creative imagination through developing their visuo-spatial abilities” (NCCA, 1991:5)” as cited by Seery et al., (in press).

Technical graphics promoted the following graphicacy areas: ‘communication of ideas, graphical problem solving, CAD competency and exploration of graphical concepts and principles through the medium of modelling’ (Seery et al., 2011).

In 2007, the technical drawing syllabus was replaced with the Design and Communication Graphics (DCG) syllabus. This new design driven syllabus was focused on developing graphicacy skills, amongst others, to ‘prepare them (the students) to be creative participants in a technological world’ (NCCA, 2007 as cited by Seery et al., in press). It is believed that ‘the design theme, which permeates the course, will empower the students to communicate their design ideas and solutions with accuracy, flair and confidence’ (NCCA, 2007:1 as cited by Seery et al., in press).

2.3.6 Typologies of graphicacy
In order to identify where graphicacy fits across the curriculum and how it is developed through teaching, literature has been studied reporting the different types of images that exist and are used.
Baynes (2008) listed 49 types of drawings used in different professions (Table 2.3), which he considers to be the key types of images most commonly used i.e. technical drawing, diagrams, photographs etc.

**Drawings used in different trades and professions taken from the Quick on the Draw exhibition**

- Analytical drawing, animation, annotated sketch, photograph, axonometric projections.
- Bird’s-eye view.
- Caricature, cartoon, chart, CGI (computer generated image), choreographic drawing, circuit diagram, CAD (computer assisted design), computer printout, concept sketch, contour drawing, cut-away.
- Design sketch, diagram, doodle.
- Elevation, extended photograph.
- Field sketch, figurative drawing.
- GPS (Global Positioning System)
- Isometric projection, illustration.
- Map, mono-print.
- Orthographic projection, observational drawing, overlay.
- Panorama, perspective, plan, pop-up, presentational drawing.
- Section, serial vision, sketch, specification, speed drawing, storyboard, symbol.
- Technical drawing, template, topographical sketch, tracing.
- X-ray section.

Table 2.3 Some of the key types of images identified by Baynes (2008)

Balchin (Table 2.4) grouped images into categories similar to the ones extracted from Baynes (2008) (Table 2.3). However there are some differences. For example, Balchin lists highway symbols, health & safety symbols and symbols on electrical equipment individually whereas Baynes used only the one category for symbols. Balchin explained this was done so because there is an immense graphicacy range which is continuously expanding (1996). His list includes some categories of these manifestations and examples of one category are named (Catling’s list of 38 map types is used in Table 2.4).
Table 2.4 Some of the ‘more obvious categories’ of graphicy given by Balchin (1996)

<table>
<thead>
<tr>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Conventional signs on maps</td>
</tr>
<tr>
<td>2. Highway symbols, warning information, direction, hazard and warning signs</td>
</tr>
<tr>
<td>3. Health and safety symbols</td>
</tr>
<tr>
<td>4. Anatomical diagrams</td>
</tr>
<tr>
<td>5. Symbols on electronic equipment</td>
</tr>
<tr>
<td>6. Logos and publicity acronyms</td>
</tr>
<tr>
<td>7. Map interpretation</td>
</tr>
<tr>
<td>8. Ground photographs</td>
</tr>
<tr>
<td>9. Art forms, graphic and computer graphics</td>
</tr>
<tr>
<td>10. Numerical quantities and information</td>
</tr>
<tr>
<td>11. Diagrammatic forms used to represent planned sequences i.e. flow chart etc</td>
</tr>
<tr>
<td>12. Block diagrams, blue prints</td>
</tr>
<tr>
<td>13. 3D representations i.e. globe, orthographic representations and pictorial sketches, perspective and grids</td>
</tr>
<tr>
<td>15. A wide range of map forms</td>
</tr>
</tbody>
</table>

**Catling’s list of 38 map types**

- Street map
- Postcard maps
- Maps in adverts
- Housing estate maps
- Tourist area maps
- Ordnance Survey maps
- Railway maps
- Room plans
- Board game maps
- Textbook maps
- Wall chart maps
- Maps drawn by children
- Maps in birthday cards
- Land-use maps
- Resort maps
- Playmate maps
- Maps of mugs
- Building site plans
- Teaching pack maps
- Building plans
- Road maps
- Road-sign maps
- Town centre maps
- Trail maps
- But route maps
- Underground maps
- Storybook maps
- Maps on stamps
- Atlas maps
- Guidebook maps
- Teacher-drawn maps
- Picture maps
- ‘Antique’ maps
- Sketch maps
- Newspaper maps
- Tea-towel maps
- Globes
- Computer software maps
Within her book, Hope (2008) refers to functions of drawings, skills involved in reading and/or creating them and different forms of drawings. These are brought together in Table 2.5. This list aids in placing graphicacy across the curriculum, as extensive examples are given which could be also seen as:

- identifying learning objectives required to complete a process (skills involved/developed)
- relevant tasks to be completed (functions of drawings)
- end products (forms of drawings)

<table>
<thead>
<tr>
<th>Function</th>
<th>Quote</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Springboard</td>
<td>‘Drawings maybe springboards, place-marking, thought-holders’...</td>
<td>1</td>
</tr>
<tr>
<td>Developing ideas</td>
<td>‘Many people in all walks of life use drawings as a way generating, developing and communicating ideas’</td>
<td>1</td>
</tr>
</tbody>
</table>

The following lists of attributes describing the ‘function’ of drawings, ‘skills involved’ and ‘forms’ of drawings have been collected by following a similar analysis process of the book

Place-making, thought-holder, informing, support, develop and expand thinking and enhance learning, develop and record thoughts and creative ideas, ubiquitous, multi-purpose, multi-faceted, multimedia, multicultural, multi-meaningful, express relationships; physical (size, scale, position in space), abstract (expressing theoretical concepts), analogue (London Underground map), symbolic representation, generate ideas, means of objectifying an inner image, support thinking in process, enhance reflection and evaluation, convey meaning, feeling, knowledge, insight and inventiveness, generating ideas, developing ideas, developing personal response, investigating form, understanding function, modelling ideas, concepts and relationships, clarifying ideas, observations and relationships, representing abstract concepts, mapping relationships, analysing concepts, establishing patterns, developing understanding, questioning observations, manipulating key concepts and relationships, developing narrative, communicating to others.

<table>
<thead>
<tr>
<th>Skills involved/developed</th>
<th>Quote</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand-eye coordination</td>
<td>‘Children’s scribbling is purposeful; they are exploring the effect of crayon on paper and developing their hand-eye coordination’s.’</td>
<td>3</td>
</tr>
<tr>
<td>Express relationships</td>
<td>‘Drawing express relationships. These relationships may be physical … abstract … or analogue …’</td>
<td>4</td>
</tr>
</tbody>
</table>

knowledge and understanding of materials, observational skills, discernment of similarities, differences and patterns, recognition of scale, proportion, motor skills, tools and techniques, development of visual literacy, language, evaluative and critical skills, formation of personal viewpoint, willingness to change and adapt, higher-order analytical skills, meta-cognitive reflective and analytical capabilities, multimedia communication skills.
Forms | Quote | Page  
--- | --- | ---  
Decorate a sculpture | ‘Drawings are not necessarily made on a flat surface. They may decorate a sculpture, or be graffiti on a railway bridge’. | 5  
Graffiti

Architectural drawings, sketches and first drafts of half-considered ideas, well-finished products that closely mirror an observation, random marks, lines, patches of colour, text items as well as drawing, including numerals and other symbols, analogues of concepts and relationships, expressive of deep emotion, purposefully dispassionate, possibilities of production in another medium, developing and communicating personal or shared meaning, exploratory of materials and techniques, parts of a series that develops ways of communicating ideas, symbolic, semiotic, metaphorical, metonymic, analogical, allegorical, paracosmic, for private pleasure, a social art, or public view.

(These ideas have been represented by Danos, taken from Hope, 2008:1-15)

Table 2.5 Functions, skills and forms of drawing brought together from Hope’s book (2008)

A similar approach has been taken in the analysis, by the author, of the research found in The Campaign for Drawing yearly booklets (2001-2007), depicting different types of drawings and skills required to understand and/or create those drawings (Table 2.6).

| Drawing types |  
| --- | ---  
**Educational purposes**

<table>
<thead>
<tr>
<th>Perception</th>
<th>Communication</th>
<th>Manipulate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe</td>
<td>Symbolize</td>
<td>Dream</td>
</tr>
<tr>
<td>Record</td>
<td>Narrate</td>
<td>Imagine</td>
</tr>
<tr>
<td>Investigate</td>
<td>Illustrate</td>
<td>Fantasize</td>
</tr>
<tr>
<td>Examine</td>
<td>Interpret</td>
<td>Visualize</td>
</tr>
<tr>
<td>Experiment</td>
<td>Explain</td>
<td>Hypothesize</td>
</tr>
<tr>
<td>Analyze</td>
<td>Negotiate</td>
<td>Test an idea</td>
</tr>
<tr>
<td>Synthesize</td>
<td>Instruct</td>
<td>Transform</td>
</tr>
<tr>
<td>Contemplate</td>
<td>Specify</td>
<td>Plan</td>
</tr>
<tr>
<td>Remember</td>
<td>Codify</td>
<td>Solve a problem</td>
</tr>
<tr>
<td>Reflect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respond emotionally</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(These ideas have been represented by Danos, taken from: Booklets Published by The Campaign for Drawing, series 2001-2010)

Table 2.6 Types of drawings and their educational purposes gathered from The Campaign for Drawing yearly booklets (Adams, Baynes & Baynes 2001-2010)

### 2.3.7 Fry’s taxonomy of graphs

Fry (1974) went a step further and placed his ideas into a taxonomy for graphical literacy, made up of 6 categories (Figure 2.2). He presented a cross-curricular perspective and his suggestions of where the types of graphs could be used in teaching (incorporated into Figure 2.2) included, in no particular order: history, literature, business, sports science, computer programming, management, mathematics, engineering, architecture, art and advertising.

Despite all of the different forms of images, Edwards (1993) believes that broadly speaking, all drawings are the same. One drawing task is no harder than any other. The same skills and ways of seeing are involved in drawing still-life setups, landscapes, the figure, random objects, even imaginary subjects, and portrait drawing. Edward suggested that it is all the same thing: one sees what’s out there (imaginary subjects are ‘seen’ in the mind’s eye) and one draws what one sees. Based on the evidence of the ‘split-brain studies’, according to Edwards, it is believed that the right hand side of the brain is responsible for creative thinking and the left hand side for logical thinking, the view came gradually that both hemispheres use
high-level cognitive modes which, though different, involve thinking, reasoning and complex mental functioning.
Figure 2.2 Taxonomy of graphs as described by Fry (1981)
2.4 Graphicacy within educational curricula

2.4.1 Graphicacy across the curriculum

The Senate Standing Committee on Education and the Arts in Australia proclaimed that the ‘non-verbal communication is equally a fundamental part in social life. Visual learning directs students toward an understanding and appraisal of the mass media and visual competence is necessary in many school subjects’ (1981:48). Visual thinking is an indispensable tool of productive and creative thought development. ‘We live in a visual world, a world which would collapse without its visual images. What has not yet happened in education, in general, is the full recognition of pictorial conceptualisation’ (Krane & Dyson, 1981:21). Fry (1981) maintains that isolated elements of graphicacy teaching exist in many schools but that it is not well developed or understood as a concept; an opinion shared also by Wilmot (1999). Aldrich and Sheppard (2000) noted that unlike literacy, graphicacy is rarely taught explicitly, despite being an important skill. Although the National Curriculum for primary science in England at Key Stage 1 (5-7 year-olds) states that children falling within this category should be able to present scientific information in a number of ways, through drawings, diagrams, tables and charts, and in speech and writing, on the whole its agenda regarding graphicacy is an implicit one. Children seem to be expected to ‘pick it up as they go along’. Despite this, graphicacy has been studied in the past. Work completed relating graphicacy to a number of different subject areas, disciplines and various forms of communication are presented below.

2.4.2 Where graphicacy fits across the curriculum

Krane and Dyson (1981:21) asserted that ‘visual thinking is an indispensable tool of productive and creative thought development’. Independent research has explored the importance of graphicacy in education e.g. the balance of text-based and visually-based resources within educational materials and its importance for learning (Verdi et al. 1996; Pettersson 1993), the significance of graphicacy in the presentation of quantitative information in an educational context (Jones et al. 2000) and the emerging research agendas associated with computer generated images. Fry (1981) gave a list with examples graphicacy use across the curriculum and stated that the Taxonomy of graphs (Fry 1974) can be used as the basis for the curriculum development i.e.:

- History: to explain events with a time line
- PE: to outline a basketball tournament with a hierarchy graph
- Vocational teacher: to give directions by means of a process chart
- Science: to explain operations with a flow chart

Similar examples could be derived from the Quantitative, Spatial, Pictorial and Hypothetical areas of the Taxonomy.
Anning (1997) studied the National Curriculum documents for England concerning the subject area of art and design & technology for Key Stages 1-5. She identified 2 different traditions of drawing between the two subject areas while teaching similar elements of graphicacy. These are some of the confusions that cause young children in the English education system to be deterred from using graphicacy as a potentially powerful tool for thinking and learning because of the conceptual and pedagogic uncertainties about drawing in school contexts.

2.4.3 Graphic representations of quantitative information

One of the unique aspects of graphics is the ability to communicate both sensory/emotional data (commonly described by words) and measured/quantified data (something described by numbers). In statistical terms, graphics can be used to communicate both qualitative and quantitative information (Tufte, 1983; Poracsky et al., 1999). Research on graphics has been carried out from a number of quite different theoretical standpoints. The reading of graphs is, in the cognitivist tradition, regarded as information processing (Leinhardt, Zaslavsky & Stein, 1990), or as the use of mental representations/models (e.g. Schnotz & Bannert, 2003). Mack and Neiss (2009) research suggests the significant importance of the utilisation of visual images in order to provide a clearer understanding of mathematics within the teaching and learning process. Veriki in a review of studies aiming to explain the role of graphical displays in learning maintained that his research ‘suggests that graphic displays are effective learning tools only when they integrate information with minimum cognitive processing’ (2002:216). However, in AMTE’s (Association of Mathematics Teacher Educators) policy statement (2006:1), AMTE declares that ‘activities that engage students in connecting multiple representations and those who invite students to analyse or create images, visualisations and simulations provide wide-ranging opportunities for mathematical exploration and sense making’.

Extensive research has been conducted around graphicacy in a mathematical / statistical context, working with children as young as primary school pupils to university students and professionals. Research included questions to determine how easy graphs and charts are to use and to read according to age, common misconceptions of students and teachers and complexity of information that can be displayed. Guthrie et al. (1993) investigated cognitive processes in undergraduate students’ understanding of graphic representations, such as graphs, tables and illustrations and found two main factors influencing performance. One factor had to do with students’ abilities to locate specific information, whereas the other concerned perception of trends and patterns or the extraction of global information. As performance on the latter factor was significantly lower than performance on the former factor, it was suggested that a substantial number of students had not learned abstraction processes related to the reading of information at an overall level.
Lewandowsky and Spence (1989) suggest that most graphs are simple. Some research has focused on this simplicity. Wainer (1984) tested 360 students to see if tables, line charts, bar charts or pie charts were inferior or superior as displays and found the line chart to be inferior to the others, which were found to be equally effective. He also reported that children, by the age of 9 years, had, on average, reached the minimum ‘acceptable’ level for an adult (enabling them to complete day-to-day actions). Ainley (2000) reported intuitive reading of graphs among 6-years-olds as an example of transparency of certain aspects of ‘graphing’ (i.e. graphicacy) (e.g. Åberg-Bengtsson, 1998; Ottosson 1988; Ottosson & Aberg-Bengtsson, 1995), whereas even the youngest elementary school pupils could handle particular features of commonly used graphs, charts and maps quite adequately. Jones et al. (2000) have, from a neo-Piagetian perspective, identified four ‘thinking levels’ for statistical thinking among pupils in grades 1-5. Kamm et al. carried out a study in the US, looking at students aged 14 to 15 (9th grade) and 17 to 18 (12th grade) in regards to reading graphic displays. The Wisconsin Tests for Reading Skill Development was used for their study. The ‘mastery’ level for this test was 80%. The test examined the ‘mastery’ in reading four different maps, dealing with graphs and tables. In reading the four map tests, there was a high increase between the percentages of students who reached mastery between the two grades (9% - 9th graders, 43% 12th graders). In reading graphs the difference was even more substantial (11% - 9th graders in comparison to 91% - 12th graders). On the table reading test however, there was a decrease in the percentage of students who achieved mastery (8% - 9th graders, 5%-12th graders) (Kamm, et al. 1977).

Another study conducted in the US by The National Assessment of Educational Progress (NAEP), reported that U.S. students need training in reading graphic displays. Of the five levels of reading proficiency, only level five, the advanced level measured the students’ ability to use the comprehension skills and strategies necessary to understand, summarise and explain graphic forms at this level (NAEP, 1985; cited in Gillespie, 1993). A similar investigation by NAEP assessed young adults whose ages ranged from 21-25. The test included ‘document literacy’ which is defined as the knowledge and skills required to locate and use information contained in maps, tables, charts, indexes etc. Most young adults performed adequately at the rudimentary, basic and intermediate levels on the document literacy section. Over half (57%) were successful at the adept level. At the advanced level, 21% of the young adults performed adequately (Kirsh & Jungeblut, 1986).

A perspective put forward by some researchers suggests the hypothesis that solving tasks related to visual displays, such as graphs, charts, maps, cartograms and diagrams of different types, relies mainly, or at least to a great extent, on visual or spatial abilities. Veriki (2002), for example, stated that ‘learners’ characteristics, such as prior subject-matter knowledge, visual-spatial ability and strategy, influence graphic processing and interact with graphical design to mediate its effects’ (261). Kozhevikon et al. (2002), in a study involving 60 undergraduate
psychology students, compared, among other things, a group of ‘visualisers’ (i.e. individuals relying primarily on imagery processes when performing cognitive tasks) with high spatial ability to a group with low spatial ability and found that the difference between the scores of the two groups also reflected the dissociation between visual (iconic) and spatial imagery when solving time – position graphs. The difference remained when controlling for other factors such as mathematical background, general intelligence and the use of meta-cognitive strategies.

Research has also been conducted to identify if intuitive reading before and after a certain age is possible and which features students of various ages can or can’t handle (e.g. Ottosson, 1988, reviewed children’s’ map-reading, understanding and difficulties of dealing with maps and concluded an understanding of spatial relationships between real world features is essential for map understanding. Projection, symbolisation and scale were not as crucial as first thought.

Other research has been completed which focused on the relationship of graphicacy to cognitive development (e.g. Spencer, Blades & Morsley, 1989), in particular spatial ability (e.g. Wilmot, 2002) and gender differences (e.g. Boardman, 1990).

2.4.4 Computer aided images

A relatively new area of research closely related to graphicacy has recently emerged, focusing on CAD (Computer Aided Design) and CGI (Computer Generated Images), looking to identify the extent to which different types of graphic displays may enhance learning and recollection of subject matter. For example, Ochaya (2005) conducted a study within an educational context which focused on the use of 3D graphics and animation software used to enhance learning. The results indicated that students, who used the interactive 3D graphic and animation instructional software, learned easier and could work better under pressure.

Another example of a study illustrating the strength of computer simulations and the impact they can have on students’ learning is from Huppert, et al. (2002), who found that the concrete and formal operational students (as defined by Piaget) in the experimental group achieved significantly higher academic achievement than their counterparts in the control group.

Even though these results do not directly satisfy the request of identifying how computer aided images enhance students’ learning, they clearly illustrate that interactive computer graphics have a great impact on their learning.
2.4.5 Text based information versus text and image based information

Aldrich & Sheppard (2000) believe that graphics offer three major advantages in comparison to text.

1. They are brief and to the point (concise) i.e. a photograph can set a scene immediately (e.g. the statue of Liberty on Liberty Island).
2. They are memorable; when Londoners are asked what line Oxford Circus is on, they generally visualise the tube map.
3. They make relationships within the information readily apparent. These include spatial relationships (as with a map showing major cities in a country, or a diagram showing how to assemble a piece of equipment), as well as non-spatial relationships (as in a table showing population figures or a line graph showing rise and fall in share values).

Investigations have also been carried out to identify individual differences in learning from texts alone and learning from text complemented by visual images. Results suggested that the visual images support for learning is not limited to the use of spatial, visual and verbal abilities alone, but it also relies on a more conceptual and broad power of reasoning. Different strategies have been identified when dealing with information given in a text only context and when it is accompanied with images. Verdi et al. (1996) conducted research which supported initial predictions which expected students to recall more facts and features after viewing the diagram prior to reading the text than students viewing the material in the reverse order. In addition, knowledge and understanding of the content and symbol system of a type of image or diagram used was found to be useful and could direct the eyes in the correct sequence to collect the information. It has also been indicated that when dealing with diagrams, the first steps are perceptually driven because the conventions and symbol systems used are primarily spatial. An example of that is the search to identify how readers search for information in diagrams by Winn (1993a), which found that unlike when reading text, the initial stages of search when reading diagrams are guided perceptually. The symbol systems and conventions of diagrams are primarily spatial and these are powerful factors in directing subsequent search (other examples of research relating to text and/or image use during teaching and learning include Arnold & Dwyer, 1975; Booher, 1975; Rigney & Lutz, 1976).

However, other authors believe that the processes involved in reading graphic displays are basically the same as those used while reading connected discourse, and strategies for teaching reading text can be applied to teaching graphics. Additionally, the reading of graphics in English occurs in the same manner as text: left to right and top to bottom (Singer & Donlan, 1982; Vacca & Vacca, 1989). Carrying out a study with somewhat different focus, Winn and Holliday (1982) investigated individual differences in learning from texts provided with complementary flowcharts. They suggested that benefiting from diagrams and charts goes beyond the use of visual (or spatial) and verbal abilities and relies on more general and abstract powers of reasoning.
2.4.6 Visual aids: Advantages

It is often assumed that, during teaching, visual images enhance understanding and learning, especially where children of ‘low abilities’ are concerned. Some studies have however found that visual images might not always be the best means to aid teaching. Ausburn (1980) stressed the point that the same learners who have reading problems appear more likely to have problems in analysing complex visuals. There also appears to be a direct relationship between verbal and visual literacy, between the ability in reading written information and the skills in analysing visual materials. Many authors believe that students may experience difficulty in reading and interpreting graphic displays because they present concepts in a concise, condensed manner; information that would otherwise require a great deal of writing. Additionally, graphic displays may use complicated artificial language to convey information (Askov & Kamm, 1982; Boardman, 1976; Fry, 1981; Weintraub; 1971, Winn, 1987). However, despite these complexities embedded in the image design, Winn supported the view that graphic displays allow students to use alternative systems of logic; they make relationships among concepts explicit and meaningful and they exploit pattern recognition, geometric shape recognition and right-brain processing (Winn, 1987). A theory exists describing how the human visual system can recognise a large number of two-dimensional shapes quickly and easily. Depending on the format, different aspects of data sets translate into different types of visual patterns. Visual displays convey information in a form that is easier to perceive. However, currently there is little information that explains what it is about the human mind that makes graphics and other pictorial displays more effective than other formats containing similar information (Pinker, 1985). Finson and Pederson have a firm believe that images are invaluable in teaching. They said that:

‘from mathematics, English, social studies and science, the message is clearly emerging that images assist student learning by providing clearer meanings for concepts they must learn... Images are not only used to build understanding of singular concepts but also are used to make connections between sets of knowledge and between the science disciplines themselves’ (2011:80).

Schemata theory provides another explanation for the apparent benefits of graphic displays. Researchers believe that information is stored in memory in structures called schemata. A schema represents what an individual knows about a topic. It forms the basis for integrating new information which tends to filter through these schemata. Activating prior knowledge is essential before new information can be integrated into long term memory and although the connection between schemata theory and graphic organisers is not explicit, the implication is that key vocabulary or concepts graphically displayed can activate prior knowledge more quickly and completely than prose. Graphic displays are believed to mimic aspects of semantic memory, structures or schemata (Clarke,1991; Dunston, 1992; Rumelhart & Ortony, 1977).
2.4.7 Visual aids: Disadvantages

Goldsmith suggests that:

‘...once the ability to produce internal structures exists (beginning around the age of 8 and 9 years old), pictures can hinder rather than help learning for tasks of a given level of difficulty and can have a levering effect, helping slower learners and retarding the others’ (as cited in Arizpe & Styles 2003:28).

Hale and Piper’s (1973) research found that under research conditions children younger than 13 have difficulty in ignoring irrelevant material. This means that a picture, if not a positive help, could become a hindrance. This is particularly an issue when the images are incorrect. Aldrich et al. (2002) described a study involving a primary school science textbook analysis. A survey was carried out to identify the use of graphics used in 34 primary science books published between 1981 and 1998. According to the study the books generally had a high ratio of graphics to text as one would expect of books aimed at this age group. However, the design of the graphics was very variable in quality even within the same book. A few graphics were found to be actually misleading. Often the reason behind this seemed to be considerations about page layout. The authors give an example of a diagram showing water and electricity supplies in a house. The diagram was also extended to form a border on the page. This changed the message of the diagram indicating that the water and electricity ran in circles round the houses, apparently miraculously replenished. In addition, a substantial proportion of the graphics added nothing to the text in terms of content. Many of the graphics were also potentially confusing because of their dependence on prior knowledge.

A substantial body of research has investigated student's difficulties (and/or misconceptions) in interpreting graphic images and maintained that understanding aspects that go beyond the most obvious proportional relationships and a simple reading-off of values may be difficult even for older pupils (e.g. Preece, 1983) and university students (Bowen, Roth & McGinn, 1999; Goldberg & Anderson, 1989). Even scientists expert in using graphs in their own research may have difficulties correctly interpreting similar graphical displays from other domains (Roth, 2001). Researchers have pointed out the stumbling block of making so-called ‘iconic’ interpretations or ‘reading the graph as a picture’, which occurs when the wrong spatial content is assigned to the display (e.g. Kerslake, 1981; Preece, 1983). However, the validity of some of these investigations has been called into question. For instance, Berg and Smith (1994) argued that the frequent occurrence of iconic misconceptions may, to a certain extent, be a function of the multiple-choice question format often used in such studies. A related and equally well known phenomenon is the ‘height for slope confusion’ (e.g. Preece, 1983; Roth, 2001) when, for example, the highest value is confused with the steepest gradient. Other reported difficulties are problems with seeing the curve in Cartesian ‘graphing’ as continuous and other problems with scales and axes (e.g. Aberg-Bengtsson, 1998; Nemirovsky & Tierney, 2001).
In another study, a comparison was made between road maps and concept maps which suggested some difficulties in reading graphic displays. A road map was found to convey more information (names, sizes of towns, distances and directions of towns from each other) than would a listing of towns. Similarly, a concept map (concepts represented in networks or charts) tells how concepts are related; however, a list of concepts would not accomplish this (Stewart, Van Kirk & Rowell, 1979). By presenting information or problems in graphic forms, we encourage students to use mental skills that may be more effective than verbal skills but which they do not usually employ (Winn, 1987). Another explanation given as to why students experience difficulties in reading graphic displays was that teachers and students are not as familiar with reading graphic displays as they should be. Several researchers suggest that many teachers lack proficiency in reading graphic displays and are unfamiliar with the notion that specific skills are necessary to read and interpret graphic displays (Askov & Kamm, 1982; Askov & Klumb, 1977).

In a different study conducted by Donlan (1997) it was found that children were more imaginative in their drawing and use of colours in response to a story if they had not previously seen the illustrations as they tend to get fixated on the ideas represented in that image. In addition, from the same study it was concluded that the pictures were more memorable than the words. Supporting evidence on a similar idea was also provided by Eggen et al. (1978). He found that the more verbal information accompanying a graph, the more errors in interpretation would be expected. He referred to this as the development of 'a threshold of cognitive overload'. However, there has been research indicating the need for both text and images for best understanding. Stone and Glock (1981) worked with young adults looking at the effects of pictures on comprehension while reading a text selection. The results indicated that subjects who viewed text with illustrations made significantly fewer errors in the assembling task than subjects who viewed text alone. No significant difference in the number of errors was found between subjects who read text alone and those who viewed illustrations alone. Similar ideas are also supported through several other studies, where they compared high school students and college undergraduates. They received mixtures of pictorial information and verbal instructions with students who received only verbal instructions. Supplementing pictures with the verbal information resulted in better performance on comprehension tests (Arnold & Dwyer, 1975; Booher, 1975; Rigney & Lutz, 1976).

Other researchers compared the comprehension of students who were given only printed information with students who received other printed information with graphic displays or graphic displays only. The researchers concluded that graphic displays do improve comprehension, and the graphic format provides a mnemonic in a way that conventional prose does not (Decker & Wheatley, 1982; Hayes & Readence, 1982).
It is common practice in class to use visual aids when first introducing a new area to help the student create connections from prior knowledge as well as to help enhance the new learning material by providing various learning stimuli. Lindsay and Norman stated that in the teaching-learning environment, ‘the problem in learning new information is not getting the information into memory; it is making sure that it will be found later when it is needed’ (1977:337). This causes distortions and vastly underestimates students’ performance, since on a practical level this position seems to imply that in a teaching-learning environment visualisation is used in the presentation phase which is later excluded from the evaluation phase (Dwyer & DeMelo 1983). If one was to follow the stimulus generalisation theory in order to increase the amount of information acquired by students as the testing situation became more similar to the situation in which the students received their instruction, results would reflect a more accurate report of the students’ learning and understanding (Hartman, 1960; Severin, 1967). This theory suggests the idea of maximising the degree of students’ achievements by having the evaluation conditions reflecting those in which the initial information was encoded. Dwyer and DeMelo (1983:12) stated that ‘probably’, the oldest and least controversial fact that can be derived from the research on human learning is that any change in the retrieval (evaluation) environment from that which occurred in the original learning environment produces marked decrements in learner performance’ (Battig, 1979).

2.4.8 Graphicacy in relation to literacy

It is this researcher’s belief, that the significance of current trends and thinking in literacy needs to be recognised and applied to graphicacy as a form of literacy. In recent years the concept of literacy has expanded to include any aspects which are considered important to develop if an individual is to be equipped to function effectively and responsibly in a technologically advanced society (Cherryholmes, 1988; Delpit, 1988; Christie, 1990; Cope & Kalantzis, 1993; Glasgow, 1994; Seels, 1994).

Other authors believe that the integration of images and visual presentations with text in textbooks, instructional manuals, classroom presentations and computer interfaces expands with time (Benson, 1997; Branton, 1999; Dwyer as cited in Kleinman & Dwyer, 1999). Studies conducted so far have found some evidence of graphicacy skills, otherwise known as visual literacy skills, having some connection to literacy and/ or numeracy skills. It is also suggested (as noted before) that the many strategies for teaching literacy are applicable to the teaching of visual literacy (McGee & Richgels, 1990; Wilmot, 1999). Fry (1981:390) spoke of ‘literacy in graphs that begins to approach word literacy’ and proposed a Taxonomy of Graphs. Another connection made between graphicacy and literacy relies on the fact that drawing a graph or an image ‘can be a creative communicating experience similar to writing a paragraph or a story. There are many ways to express the same idea graphically, just as a writer can express a written idea in a variety of ways’ (Fry, 1981:388).
However, the degree of difficulty in dealing with the various communication techniques might differ. According to Balchin ‘the full extent of graphicacy is even more complex than that of literacy and numeracy. It ranges from monochrome to multi-colour and from simple and complex geometrical organisation to pictorial representation in which colours, texture, balance and patterns all need consideration’. He continued by saying that ‘such is the complexity and sophistication of graphicacy that it can be incomprehensible and off-putting to ingraphicate adults’ (Balchin, 1996:5). In 1976 however, he published a contradictory statement;

‘Fundamentally, neither words nor numbers nor diagrams are simpler or more complex, superior or inferior. They are only more suitable or less suitable for particular purposes and each may range from the very simple to the highly complex. They are complementary but not interchangeable, and can only achieve their highest level of communication when properly integrated.’

(Balchin, 1976:195)

2.4.9 Multiple intelligences and visual literacy

Cross (1998) called the ability to design part of human intelligence. He supported that this ability is natural and widespread amongst the human population Before the concept of ‘multiple intelligences’ was first coined by Gardner around the 1980s, Balchin described graphicacy as the educated counterpart of the visual-spatial aspect of human intelligence and communication (Balchin, 1976). He talked about the ‘existing 120 different aspects of intelligence’ and grouped them into:

1. spatial ability, which includes map-reading and spatial planning (the first to evolve. Animals possess enough to allow them to recognise landscape)
2. social noise such as oral language (the second basic mode to evolve)
3. written communication and

Edwards (1993) stated that the way visual information (graphicacy) is processed is different from the way we ordinarily process information (oracy, literacy and numeracy). Furthermore, Levin (1976) has found that both children and adults remember pictures of objects better than names of objects. Gardner identified at least 8 different intelligences humans have in varying degrees. These are linguistic, logical-mathematical, musical, spatial, bodily-kinaesthetic, personal, naturalist and existential. Most often spatial intelligence is considered to be the one connecting with aspects of art but Perkins emphasises the interconnectedness of thinking involved in appreciating art, which inevitable draws on other intelligences. ‘By cultivating awareness of our own thinking, asking ourselves good questions, guiding ourselves with strategies, we steer our experiential intelligence in fruitful directions’ (1994:82-5). That is an idea also supported by Arizpe and Styles who have identified through their study different intelligences used by children when analysing picture books, such as personal intelligence, linguistic, naturalist and existential intelligence (Arizpe & Styles 2003 46). In addition,
Arnheim (1989) believes that within the human abilities of vision lie the function of intelligence and perception which is a cognitive event, interpretation and meaning which are inseparable aspects of seeing and warned that educational processes can avert or promote these (Eisner in Arnheim 1989:4-7). This is a common opinion amongst authors, a view both Piaget and Gardner supported.
2.5 Summary of chapter 2

The process of selecting the appropriate papers, journals and books has been described so the reader can understand the extent of this review. A careful selection procedure had to be followed to allow sufficiently focused analysis.

The literature reported on many academics’ established positions concerning aspects of communication; an aspect of learning and/or part of the application of what has been learnt. Balchin in 1996 used the terms ‘incoming’ or ‘outgoing’ to describe these, ‘according to the direction of the flow (of the information)’; different terms have been used to explain these such as reading & comprehending and drawing, encoding and decoding information in graphic form (Fry, 1974:388; Catling, 1995; Molyneux and Tolley, 1987). The meaning of graphicacy (research question 1 [RQ 1]) reported in the literature have been reviewed. The elements of graphicacy are described (Table 2.7), and many of these are broken down into individual skills (Table 2.8).

In general, most of the views expressed on the area of graphicacy share the same beliefs on the importance of graphicacy as a basic skill and the need for it to be included in the school curriculum along with literacy, numeracy and articulacy. A very successful analogy used by Balchin to describe its importance was ‘graphicacy should be the fourth ace of the pack’ (Balchin & Coleman, 1965:85). The fact that it has been identified and studied in numerous different countries, including Australia, South Africa, Ireland, the UK and the USA; many of whom have asked for Balchin’s 1965 journal paper to be reprinted at some stage, indicates the strength of the common-ground surrounding the concept of graphicacy and its potential to support curriculum development.

Information has also been gathered regarding graphicacy and different subject areas. Graphicacy’s significance has been identified within education as well as in the professional world. Research has been conducted concerning the relationship of graphicacy to cognitive development (e.g. Spencer, Blades & Morsley, 1989), in particular spatial ability (e.g. Wilmot, 2002) and gender differences (e.g. Boardman, 1990). Prior research has also explored the importance of graphicacy in education e.g. the balance of text-based and visually-based resources within educational materials and its importance for learning (Verdi et al., 1996), the significance of graphicacy in the presentation of quantitative information in an educational context (Jones et al., 2000) and the emerging research agendas associated with computer generated images. Through the existing work reviewed, a view of where graphicacy fits across the curriculum (RQ 2; has graphicacy across the curriculum been studied before? If so, what were the findings? RQ 5; where does graphicacy fit across the curriculum? RQ 7; what are the main similarities of the use of images across different subjects?) has been identified. Glimpses on how graphicacy appears in ‘teaching’ have also been introduced, especially through the work completed on cartography and graph reading. The review also indicates the answer to RQ 2
as research related to graphicacy within different subject areas across the curriculum has been identified. In addition, some of the existing work has been brought together forming two contradictory groups; opinions supporting the advantages of using visual aids and opinions supporting the disadvantages of using them. This section answers partially RQ 2 (has graphicacy across the curriculum been studied before?) and RQ 7 (what are the main similarities of the use of images across different subjects?), as it refers to areas, instances and similar ways graphicacy is used in the curriculum, such as graphs used in science and mathematics textbooks. References to incoming skills relating to maps are also made in a later section, where tests of graphicacy are described.

Further study will be required to answer satisfactory RQ 5 and RQ 6 (how does graphicacy appear in 'teaching'?). The literature review has identified certain subject areas which deal with graphicacy, but it does not provide fully a cross-curricular view.

Graphicacy seems to be considered as a form of intelligence by some authors, which would lead to the belief that it can be nurtured and developed. Suggestions are made on how to enhance graphicacy which gave potential indications for aspects of continuity and progression relating to RQ 8 (are there main stages/levels of drawing, mark making or other graphicacy related abilities that children go through?) and RQ 9 (how does graphicacy capability change/develop during the years of 11-14 years?).

The following table summarises the information gathered through literature, regarding elements of graphicacy (relating to RQ 1; what is graphicacy?). Areas marked with ‘#’ are ideas that have been represented by the researcher, taken from their original texts. Further analysis of the information listed below will be required in order to provide a clear and sharp description of what graphicacy is, thus resolving RQ 1 more fully.

During the literature review it became apparent that the writing of different authors concerning graphicacy could be divided into categories such as: incoming and outgoing skills and different types of images. These were collated to form categories as shown in Tables 2.7 – 2.14. The key authors from which the ideas were drawn included; Anning (1997), Adams & Baynes (2001), Balchin (1985) Cross (2006), Wilmot (1999), Van Harmelen (2002), Aberg-Bengtsson (2006), Liben & Downs, (1993), Roth (2005, 2006), Poracsky et al. (1999) and Archer (1973). Where applicable, the author from whom ideas or terms have been taken, are noted. For example, the term Art has been used in the context Archer defined in 1973. The table was created to summarise the results of the literature review and to enable patterns to emerge, including consistent and conflicting views. Often authors talked about a group of images requiring a set of skills to create or understand them. For that reason, when images are broken down into more specific groups, repetition often occurs.
Author's descriptions of image categories have been identified and grouped under titles of artistic/pictorial/graphic arts. Elements (images) which fall under this category based in the literature are placed in the left column. Descriptions of the main attributes of this category and each element are identified. Skills and abilities required to deal with the elements have been grouped regarding the direction of flow of information; incoming and outgoing perspectives.

Table 2.7 lists the elements under the category of artistic images. According to Fry (1981) and Balchin (1976, 1985), these deal with the concepts of size, shape, direction, conventional signs, linear and angular measurements, co-ordinates, densities, colour distinctions and types of patterns. Five elements have been identified which according to the literature fit under this category. These are: art, life drawing, landscape drawing, portraits and still life.

<table>
<thead>
<tr>
<th>TYPE Drawn from: Experts/ authors</th>
<th>INCOMING*SKILLS (understanding)</th>
<th>OUTGOING* SKILLS (creating)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTISTIC —[referred by Fry, 1981 as Pictorial], [referred by Balchin, 1985 as Graphic arts]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art</td>
<td># Imagination, subjectivity</td>
<td># Learn to see and feel what you see, eye hand coordination,</td>
</tr>
<tr>
<td>Archer, 1973</td>
<td>(Cross, 2006)</td>
<td>translating a perceived image into a graphic outcome</td>
</tr>
<tr>
<td></td>
<td># Communicate sensory and</td>
<td>(Anning, 1997) Perception; observe, record,</td>
</tr>
<tr>
<td></td>
<td>emotional data</td>
<td>investigate, examine, experiment,</td>
</tr>
<tr>
<td></td>
<td>(Poracsky et al., 1999)</td>
<td>analyse, synthesise, contemplate,</td>
</tr>
<tr>
<td></td>
<td># Artistic statement (Anning, 1997)</td>
<td>remember, reflect, respond</td>
</tr>
<tr>
<td></td>
<td># Analogy, metaphors, evaluation</td>
<td>emotionally (Adams &amp; Baynes</td>
</tr>
<tr>
<td></td>
<td>(Cross, 2006)</td>
<td>2001)</td>
</tr>
<tr>
<td></td>
<td>Perception, sensibility and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>handling of emotional meaning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Archer, 1973)</td>
<td></td>
</tr>
<tr>
<td>Life drawing</td>
<td># Imagination, subjectivity</td>
<td># Learn to see and feel what you see, eye hand coordination,</td>
</tr>
<tr>
<td>Anning, 1997</td>
<td>(Cross, 2006)</td>
<td>translating a perceived image into a graphic outcome</td>
</tr>
<tr>
<td></td>
<td># Communicate sensory and</td>
<td>(Anning, 1997) Perception; observe, record,</td>
</tr>
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<td></td>
<td>emotional data</td>
<td>investigate, examine, experiment,</td>
</tr>
<tr>
<td></td>
<td>(Poracsky et al., 1999)</td>
<td>analyse, synthesise, contemplate,</td>
</tr>
<tr>
<td></td>
<td># Analogy, metaphors, evaluation</td>
<td>remember, reflect, respond</td>
</tr>
<tr>
<td></td>
<td>(Cross, 2006)</td>
<td>emotionally (Adams &amp; Baynes</td>
</tr>
<tr>
<td></td>
<td>Perception; observe, record,</td>
<td>2001)</td>
</tr>
<tr>
<td></td>
<td>investigate, examine, experiment,</td>
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<tr>
<td></td>
<td>analyse, synthesise, contemplate,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>remember, reflect, respond</td>
<td></td>
</tr>
<tr>
<td>Landscape drawing</td>
<td># Imagination, subjectivity</td>
<td></td>
</tr>
<tr>
<td>Anning, 1997; Adams &amp; Baynes, 2001; Balchin, 1985</td>
<td>(Cross, 2006)</td>
<td></td>
</tr>
<tr>
<td></td>
<td># Communicate sensory and</td>
<td></td>
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<td></td>
<td>emotional data</td>
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<tr>
<td></td>
<td>(Poracsky et al., 1999)</td>
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<tr>
<td></td>
<td># Analogy, metaphors, evaluation</td>
<td></td>
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<tr>
<td></td>
<td>(Cross, 2006)</td>
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</tr>
<tr>
<td></td>
<td># Learn to see and feel what you see, eye hand coordination,</td>
<td></td>
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<tr>
<td></td>
<td>translating a perceived image into a graphic outcome</td>
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<td></td>
<td>(Anning, 1997) Perception; observe, record,</td>
<td></td>
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<tr>
<td></td>
<td>investigate, examine, experiment,</td>
<td>investigate, examine, experiment,</td>
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<tr>
<td></td>
<td>analyse, synthesise, contemplate,</td>
<td>analyse, synthesise, contemplate,</td>
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<td></td>
<td>remember, reflect, respond</td>
<td>remember, reflect, respond</td>
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<td></td>
<td>emotionally (Adams &amp; Baynes</td>
<td></td>
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<tr>
<td></td>
<td>2001)</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Incomingskills</td>
<td>Outgoing skills</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Portraits  |APONG, 1997  
# Imagination, subjectivity (Cross, 2006)  
# Communicate sensory and emotional data (Poracsky et al., 1999)  
# Analogy, metaphors, evaluation (Cross, 2006) | # Learn to see and feel what you see, eye hand coordination, translating a perceived image into a graphic outcome (Anning, 1997)  
Perception; observe, record, investigate, examine, experiment, analyse, synthesise, contemmate, remember, reflect, respond emotionally (Adams & Baynes 2001) |
| Still life |APONG, 1997; 
Adams E & Ken Baynes, 2001  
# Imagination, subjectivity (Cross, 2006)  
# Communicate sensory and emotional data (Poracsky et al., 1999)  
# Analogy, metaphors, evaluation (Cross, 2006) | # Learn to see and feel what you see, eye hand coordination, translating a perceived image into a graphic outcome (Anning, 1997)  
Perception; observe, record, investigate, examine, experiment, analyse, synthesise, contemmate, remember, reflect, respond emotionally (Adams & Baynes 2001) |

Table 2.7 Summary of graphicacy artistic/pictorial/graphic arts elements

Fry categorises drawing elements as pictorial, relating to the characteristics required concerning focused awareness by the reader or maker. All three types of images (elements) listed in Table 2.8 have been identified to be true representations of thoughts, ideas or scenes. These include drafts, sketching and drawings.
Table 2.8 Summary of graphicacy drawing/pictorial elements

<table>
<thead>
<tr>
<th>TYPE</th>
<th>INCOMING SKILLS</th>
<th>OUTGOING SKILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drawing</strong></td>
<td>Reflection, critical thinking (Cross, 2006) envision artefacts, rehearse, clarify and explore ideas or feelings (Anning, 1997)</td>
<td>Learn to see and feel what you see (Anning, 1997) Perception; observe, record, investigate, examine, experiment, analyse, synthesise, contemplate, remember, reflect, respond emotionally Manipulate; imagine, fantasise, visualise, hypothesise, test an idea, transform, plan, solve a problem. Communication; symbolise, narrate, illustrate, interpret, explain, negotiate, instruct, specify, codify, document, record, develop (Adams &amp; Baynes 2001) Convey spatial information, utilise some form or symbolic language (Wilmot, 1999)</td>
</tr>
<tr>
<td><strong>Sketching</strong></td>
<td># Envision artefacts, formulate or record plans, rehearse, clarify and explore ideas or feelings (Anning, 1997) Convey spatial information, utilise some form or symbolic language (Wilmot, 1999)</td>
<td># Learn to see and feel what you see (Anning, 1997) Perception; observe, record, investigate, examine, experiment, analyse, synthesise, contemplate, remember, reflect, respond emotionally Manipulate; imagine, fantasise, visualise, hypothesise, test an idea, transform, plan, solve a problem. Communication; symbolise, narrate, illustrate, interpret, explain, negotiate, instruct, specify, codify, document, record, develop (Adams &amp; Baynes 2001) Convey spatial information, utilise some form or symbolic language (Wilmot, 1999)</td>
</tr>
</tbody>
</table>

Six elements have been recognised as diagrams, listed in Table 2.9. These include annotated, engineering/technical, architectural, projections, perspective and exploded. Many authors have talked and described different elements of diagrams. According to Fry, this is another type of pictorial category. All elements described in this category convey some kind of technical information.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decode information in graphic forms (Wilmot, 1999)</td>
<td>Convey spatial information, utilise some form of symbolic language, encode information in graphic forms (Wilmot, 1999)</td>
<td></td>
</tr>
</tbody>
</table>

### Engineering/Technical

**Anning, 1997; Adams & Baynes, 2001; Riding & Boardman, 1983**;

- # Practicality, ingenuity (Cross, 2006)
- # Communicate or converse (Anning, 1997)
- # Objectivity, rationality, neutrality (Cross, 2006)
- # Practicality, ingenuity, empathy, concern for appropriateness (Cross, 2006)
- Special-visual ability. Discriminate various symbols, analyse their meaning and relation to adjacent symbols. Construct an internal representation of the information. (Boardman, 1983)
- Spatial development (Van Harmelen, 2002)
- Decode information in graphic forms (Wilmot, 1999)

### Architectural

**Anning, 1997; Balchin, 1985**

- # Communicate or converse (Anning, 1997)
- # Objectivity, rationality, neutrality (Cross, 2006)
- # Practicality, ingenuity, empathy, concern for appropriateness (Cross, 2006)
- Spatial development (Van Harmelen, 2002)
- Decode information in graphic forms (Wilmot, 1999)

### Projections (Orthographic, oblique, isometric)

**Anning, 1997; Adams & Baynes, 2001**;

- # Communicate or converse (Anning, 1997)
- # Practicality, ingenuity, empathy, concern for appropriateness (Cross, 2006)
- Spatial development (Van Harmelen, 2002)
- Decode information in graphic forms (Wilmot, 1999)

### Projections (Orthographic, oblique, isometric)

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### Projections (Orthographic, oblique, isometric)

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- Decode information in graphic forms (Wilmot, 1999)

### Projections (Orthographic, oblique, isometric)

**Anning, 1997; Adams & Baynes, 2001**;

- # Communicate or converse (Anning, 1997)
- # Practicality, ingenuity, empathy, concern for appropriateness (Cross, 2006)
- Spatial development (Van Harmelen, 2002)
- Decode information in graphic forms (Wilmot, 1999)
### Table 2.9 Summary of graphicacy diagrams/pictorial elements

<table>
<thead>
<tr>
<th>Perspective</th>
<th># Conceptualisation, integrative thinking <em>(Poracsky et al., 1999)</em></th>
<th>Communication; symbolise, narrate, illustrate, interpret, explain, negotiate, instruct, specify, codify, document, record, develop, manipulate; imagine, fantasise, visualise, hypothesise, test an idea, transform, plan, solve a problem <em>(Adams &amp; Baynes 2001)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># Communicate or converse <em>(Anning, 1997)</em></td>
<td>Spatial development <em>(Van Harmelen, 2002)</em></td>
</tr>
<tr>
<td></td>
<td># Practicality, ingenuity, empathy, concern for appropriateness <em>(Cross, 2006)</em></td>
<td>Convey spatial information, utilise some of symbolic language, Encode information in graphic forms <em>(Wilmot, 1999)</em></td>
</tr>
<tr>
<td></td>
<td>Spatial development <em>(Van Harmelen, 2002)</em></td>
<td>Convey spatial information, utilise some of symbolic language, Encode information in graphic forms <em>(Wilmot, 1999)</em></td>
</tr>
<tr>
<td></td>
<td>Decode information in graphic forms <em>(Wilmot, 1999)</em></td>
<td>Convey spatial information, utilise some of symbolic language, Encode information in graphic forms <em>(Wilmot, 1999)</em></td>
</tr>
</tbody>
</table>

Table 2.10 lists 2 elements which make up the computer aided design category: 3D virtual environment and 3D virtual products. These are elements created using computer software. Balchin uses a similar term to describe these, whereas Fry relates to the characteristics required concerning focused awareness by the reader or maker i.e. Spatial. For this category the outgoing skills appear to outnumber the incoming skills.
<table>
<thead>
<tr>
<th>TYPE</th>
<th>INCOMING SKILLS</th>
<th>OUTGOING SKILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawn from:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experts/ authors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAD [referred by Balchin, 1996 as <strong>Computer Graphics</strong>]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D virtual environment</td>
<td># Conceptualisation, integrative thinking (Poracsky et al., 1999) # Communicate or converse (Anning, 1997)</td>
<td>Manipulate; imagine, fantasise, visualise, hypothesise, test an idea, transform, plan, solve a problem, communication; symbolise, narrate, illustrate, interpret, explain, negotiate, instruct, specify, codify, document, record, develop, perception; observe, record, investigate, examine, experiment, analyse, synthesise, contemplate, remember, reflect, respond emotionally (Adams &amp; Baynes 2001)</td>
</tr>
<tr>
<td>Anning, 1997; Adams &amp; Baynes, 2001; Balchin, 1985</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D virtual products</td>
<td># Conceptualisation, integrative thinking (Poracsky et al., 1999) # Communicate or converse (Anning, 1997)</td>
<td>Manipulate; imagine, fantasise, visualise, hypothesise, test an idea, transform, plan, solve a problem, communication; symbolise, narrate, illustrate, interpret, explain, negotiate, instruct, specify, codify, document, record, develop, perception; observe, record, investigate, examine, experiment, analyse, synthesise, contemplate, remember, reflect, respond emotionally (Adams &amp; Baynes 2001)</td>
</tr>
<tr>
<td>Anning, 1997; Adams &amp; Baynes, 2001; Balchin, 1985</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.10 Summary of graphicacy CAD/ spatial/ computer graphics elements

Table 2.11 lists the elements which require linear or sequential thought process in some form which includes cartoons and story boards. All the elements follow a logical sequential flow when illustrating information. This is another category which seems easier to understand and learn from an incoming perspective when compared with the outgoing skills required.
Adams & Baynes., 2001; Wilmot, 1999

Spatial development (Van Harmelen, 2002)

Convey spatial information, utilise some form of symbolic language (Van Harmelen, 2002)

Storyboards
Anning, 1997; Adams & Baynes, 2001

Formulate and record plans (Anning, 1997)

# Communicate or converse (Anning, 1997)

Manipulate; imagine, fantasise, visualise, hypothesise, test an idea, transform, plan, solve a problem, communicate; symbolise, narrate, illustrate, interpret, explain, negotiate, instruct, specify, codify, document, record, develop (Adams & Baynes 2001)

Table 2.11 Summary of graphicacy sequential/linear elements

Charts and graphs are seen as symbolic quantitative representations. Table 2.12 suggests that they might be cases of ‘simple in design, complex in data’ (Beh 2010). The incoming skills found in literature outnumber the outgoing skills in this case.

<table>
<thead>
<tr>
<th>TYPE Drawn from: Experts/authors</th>
<th>INCOMING SKILLS</th>
<th>OUTGOING SKILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYMBOLOCIC [referred by Fry, 1981 as Quantitative] [referred by Anning, 1997 as Mathematical]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charts</td>
<td># Objectivity, rationality, neutrality (Corss, 2006)</td>
<td>Perception, observe, record, investigate, examine, experiment, analyse, synthesise, contemplate, remember, reflect, respond emotionally, communication; symbolise, narrate, illustrate, interpret, explain, negotiate, instruct, specify, codify, document, record, develop (Adams &amp; Baynes 2001)</td>
</tr>
<tr>
<td>Anning, 1997; Aberg-Bengtsson &amp; Ottosson, 2006; Balchin, 1985</td>
<td># Communicate relative values, quantitative comparisons, numerical trends, capture connection, conceptualisation (Poracsky et al., 1999)</td>
<td></td>
</tr>
<tr>
<td># Communicate or converse (Anning, 1997)</td>
<td></td>
<td></td>
</tr>
<tr>
<td># Objectivity, rationality, neutrality (Cross, 2006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handle and communicate quantitative information. Record, analyse and communicate data. Rely on visual or spatial abilities. Ability to locate specific information, perception of trends and patterns, and the extraction of global information (Aberg-Bengtsson, 2006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantitative graphics (Poracsky et al., 1999)</td>
<td></td>
<td></td>
</tr>
<tr>
<td># Objectivity, rationality, neutrality (Corss, 2006). # Communicate relative values, quantitative compar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
comparisons, numerical trends, capture connection, conceptualisation  
(Poracsky et al., 1999)

Handle and communicate quantitative information. Record, analyse and communicate data. Rely on visual or spatial abilities. Ability to locate specific information, perception of trends and patterns, and the extraction of global information(Aberg-Bengtsson & Ottosson, 2006)

Special-visual ability. Discriminate various symbols, analyse their meaning and relation to adjacent symbols. Construct an internal representation of the information  
(Boardman, 1983)

Table 2.12 Summary of graphicacy symbolic/ quantitative/ mathematical elements

Symbols were referred to by a number of authors regarding the skills required to deal with them. Fry categorises them as omitted (Table 2.13); an element that does not fit under a category with other identified elements.

Table 2.13 Summary of graphicacy omitted elements
The elements maps/cartograms, photographs and posters/ advertisements listed in Table 2.14 represent a message, a person, a scene or an area. Much research has been conducted on map reading and cartography which resulted in a long list of incoming skill attributes.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>INCOMINGS KILLS</th>
<th>OUTGOING SKILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maps / cartograms</td>
<td>Aberg-Bengtsson &amp; Ottosson, 2006; Riding &amp; Boardman, 1983; Adams &amp; Baynes, 2001; Balchin, 1996; Wilmot, 1999; Balchin, 1985</td>
<td></td>
</tr>
<tr>
<td>Photographs</td>
<td>Roth, 2005; Balchin, 1996;</td>
<td>Spatial development (Van Harmelen, 2002) Pattern recognition (Balchin, 1976)</td>
</tr>
<tr>
<td>Source</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Posters / advertisements Wilmot, 1999</td>
<td>Qualitative graphics (Poracsky et al., 1999)</td>
<td>Convey spatial information, utilise some form of symbolic language (Wilmot, 1999)</td>
</tr>
</tbody>
</table>

Table 2.14 Summary of graphicacy symbolic/ spatial/ mathematical elements
CHAPTER THREE

Literature review (Part 2): Progression and development of graphicacy and students’ learning

Introduction to chapter 3

This review analyses published literature concerning the development of graphicacy in children. The information is presented chronologically and notes different perspectives from a range of areas, such as psychology and education. The key words used to collect the information reviewed in this chapter are listed in section 3.1. A general understanding of the way children process information is presented in section 3.2 along with drawing developmental stages broken down according to specific ages. A number of agreed and contrasting views from various authors are then brought together. A rationale is provided as to why some authors’ work features prominently through this review. Section 3.3 is focused on reporting more specific graphicacy skills and abilities related to developmental stages based on a number of authors’ work. A general overview of the renowned cognitive development theory by Piaget giving a synopsis on the area is also investigated. In section 3.4 perspectives from different authors are reported and discussed, focused on the skills and abilities related to outbound elements of graphicacy, and on how children respond to images. Section 3.5 reports arguments on the debate of ‘nature or nurture’, and evidence of developmental stages relating to specific age-ranges is provided. Section 3.6 presents the contrasting research outcomes relating to the influence of gender on graphicacy. Section 3.7 is a summary of this chapter and plans for the next steps taken are described.
3.1 Literature review research methodology

The same search engines were used to gather relevant publication for this literature review as described in Chapter 2. A similar process was also followed in short-listing the potentially relevant publications. The main key words used for this section are listed in Table 3.1.

<table>
<thead>
<tr>
<th>Key words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence, perception, graphicacy, visual thinking, creative growth, visual literacy, visual perception, critical graphicacy, mental growth, visual intelligence, developmental stages, reading images, visual communication, understanding images, developmental stages of child art, drawing development in children, progressive stages of children's drawings, sequential development of visual perception, children's' visual development skills, twenty scribbles, children understanding of symbolic representations</td>
</tr>
</tbody>
</table>

Table 3.1 Key words used in the online searches for the literature reviewed in chapter 3
3.2 Development of graphicacy in children

Spatial perception and spatial conceptualisation are the foundations on which graphicacy rests. Understanding graphicacy requires an understanding of children’s perceptual abilities and spatial conceptual development (Boardman, 1976, 1983).

Perception involves both a physical process of 'seeing' and an intellectual one of interpreting. It is bound up with the development of cognitive skills. It is only by means of thought processes that a child remembers and recognises objects that he/she has seen, heard, tasted or touched (Grove, Hauptfleisch & Sonnekus, 1989).

3.2.1 Rationale of the review and summary of key authors’ work

Previous research concerning childrens’ drawing developmental stages has been described many times before. The work of Lowenfeld, Gaitskell and Kellogg, have been chosen as the key authors to base this literature review on because their work has long been accepted and established in many educational contexts. Their work is referenced frequently in this review. However, each author’s view and judgment on criteria determining each development stage is different. Lowenfeld, Kellogg and Gaitskell all supported the belief that there is an observable development order for children’s drawing abilities and they fall into predictable age groups, where they adopt recognizable modes of artistic expressions. Through research they have identified, named and described these stages.

Lowenfeld connected intellectual growth, psychosocial stages and children's drawings to generate six stages for the development of children’s drawings (Table 3.2). His appreciation of individual’s work is largely characterised by interpretations of a psychological nature. He viewed children’s art as documents that reveal child personality, instead of as just lines and forms, as was the case in Kellogg’s work. He claimed that children's work is either 'visual' or 'haptic'; reflecting the child’s sense of touch and their muscular and kinaesthetic awareness. His terms describe characteristics that have more to do with matters of character.

Gaitskell studied children’s art for many years while working closely with school teachers and sought to give some guidelines to help teachers teach and evaluate student’s art. Four main stages were identified which were based on the type of images created by the child (Table 3.3).

Kellogg has drawn her conclusions from work conducted over a period of 20 years, with a very large number of drawings analysed. Kellogg’s studies have been focused around children’s drawing development between the ages of 1-8. Kellogg’s work has produced detailed phases with clear progression stages; and represents perhaps the most detailed available analysis of children's development in drawings between those ages (Table 3.4).
The examples of children’s drawings provided by Kellogg for each stage make the analysis of children’s drawings clearer and more feasible by others.

<table>
<thead>
<tr>
<th>Stage 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scribbling stage (2 until 3 years old)</td>
</tr>
<tr>
<td>1. Disordered scribbles</td>
</tr>
<tr>
<td>2. Scribbling, marks are more orderly</td>
</tr>
<tr>
<td>3. Name scribbles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>The pre-schematic stage (3 to 4 until 6 years old)</td>
</tr>
<tr>
<td>1. Conscious creation of form</td>
</tr>
<tr>
<td>2. Symbols, first representational attempt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The schematic stage (6 until 8 years old)</td>
</tr>
<tr>
<td>1. Schematic generalization, a definite way of portraying an object. There is definite order in space relationships: everything sits on the base line.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>The gang stage: drawing realism (8 until 12 years old)</td>
</tr>
<tr>
<td>1. Space is discovered and depicted with overlapping objects</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>The pseudo-naturalistic stage (12 until 14 years old)</td>
</tr>
<tr>
<td>1. This stage marks the end of art as spontaneous activity. Strive to create “adult-like” naturalistic drawings using light and shadow, space and three dimensionality, fold and motion with mixed success</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>The period of decision: naturalistic stage (14 to 16 years old onwards)</td>
</tr>
<tr>
<td>1. Natural development will cease unless a conscious decision is made to improve drawing skills</td>
</tr>
</tbody>
</table>

Table 3.2 Lowenfeld’s stages of artistic development (1964)

<table>
<thead>
<tr>
<th>Stage 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manipulation stage (starts between 1-5 years old)</td>
</tr>
<tr>
<td>1. Scribbles (random movement)</td>
</tr>
<tr>
<td>2. Organised scribbles (controlled movement)</td>
</tr>
<tr>
<td>3. Scribbles gaining names (controlled movement)</td>
</tr>
<tr>
<td>4. Recognisable objects (purposely drawn)</td>
</tr>
<tr>
<td>Stage 2</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Symbolic stage (starts between 3-7 years old)</td>
</tr>
<tr>
<td>1. Use of symbol (distinct marks or symbols that stand for objects i.e. stick man)</td>
</tr>
</tbody>
</table>

Table 3.3 Stages of artistic production, by Gaitskell (*Children and Their Art*, 1958)

According to Kellogg, children go through the following main stages:

- **Scribble stage (1½ - 2 years old)**
  1. Twenty scribbles have been identified and named by Kellogg

- **Pattern stage**
  1. Placement patterns

- **Shape stage**
  1. Emergent diagrams are in-between pure scribbles and outlined shapes
  2. Diagrams are definite shapes drawn with single lines forming outline forms. These include circles, triangles and other shapes

- **Design stage (3 + 4 years old)**
  1. Combines are 2 diagrams joined together
  2. Aggregates are 3 or more diagrams joined together

- **Mandalas; allow a natural transition between abstract and pictorial work**
  1. Suns
  2. Radials
  3. Humans

- **Pictorial drawing (4 + 5 years old)**
  1. animals
  2. buildings vegetation
  3. transportation

Table 3.4 Kellogg’s stages of children’s drawings (1979)
3.2.2 Children’s drawing abilities by age group

Age one
Piaget and Inhelder (1956) defined the development of children’s drawing with a time span related to Piaget’s theory of cognitive development, starting with the ‘sensori-motor’; a period prior to language and logical thought. During this time the child can make miscellaneous random lines as their underdeveloped muscles allow no coordination. Kellogg notes that she knows of no data regarding the ability of the one year old child (Kellogg, 1959).

Age two
The first stage of drawing or mark making is often referred to as ‘Scribblings’ or ‘random scribblings’ and it is considered universally to be a child’s first mark. At this stage children continue placing one scribble over the other while starting to produce ‘Placement Patterns’. Kellogg suggests that this is evidence of good mental functioning. Children start placing their markings in relation to the edges of the paper. According to Kellogg, basic scribbles are something nearly all 2 years old can do (Kellogg 1959). Gaitskell believes that when children first go through the manipulation stage, their mark making is done in an exploratory and random fashion and then to a controlled movement that leads to making art on purpose such as recognisable or nameable objects (Gaitskell, 1958). Others believe that scribbles ‘demonstrate awareness of pattern and increasing eye-hand coordination’ instead of just being ‘aimless or uncoordinated movements’ (Thomas & Silk, 1990; Lowenfeld 1964; Kellogg, 1970). Furthermore, Kellogg believes that visual interest is an essential component of scribbling and names twenty basic scribbles made by two year olds and younger children (Figure 3.1) which ‘are the building blocks of art’. The numbered sequence of the scribbles does not represent or suggest a developmental order. However, Edwards (1993) notes that children start by creating circular movements which, she believes, appear first because they are most natural anatomically.

From an early age children start labelling their scribbles after they have drawn them. From around 2 years old, children might label or name the scribble before they draw it, which they might change later if it reminds them of something different. Kellogg believes that naming the scribbles is the result of adult influence, whereas Lowenfeld believes that to be one of the important stages in human development as it indicates a change of thinking from a mere kinaesthetic to an imaginative stage. He believes that this is a sign of the child referring in his scribbling to mental pictures, instead of being concerned only with motions (1952). Lowenfeld classifies this as the first developmental stage from 1 to 4 years old.
Parson gave descriptions of 3 developmental stages of aesthetic response. For years 1 to 2, the first stage, he calls ‘favouritism’, where a child’s preference is paramount, there is little awareness of the point of view of others and liking a picture is identical to judging it. Piaget shares the same views and adds that this stage is marked by the child’s ability to create, label, and name the ‘scribbles’ as symbols. Objects undergo embellishments and colour change in the search for greater identification while spatial understanding is not yet developed so the objects appear to ‘float’. Baynes (1996) agrees with Kellogg and Parson supporting their view that children are ego-centric at this stage and adds that children in this age begin to grow an awareness of self in relation to space, develop fine motor skills and begin to manipulate small objects which help in developing hand-eye-coordination. They start naming objects and obey commands.

Between the ages of 2 and 3 most children learn to make a number of definite marks which they use in their drawings repeatedly (Lowenfeld 1959, Edwards 1993, Dondis 1973, Hope 2008). In Kellogg’s descriptions these are identified as ‘basic scribbles’ (Kellogg 1970). She
believed that every 2 year-old draws curved and straight lines which make the components of the Sun. Nevertheless; according to Kellogg the child rarely makes a circle with lines crossing the perimeter before age three (Kellogg 1970). According to Piaget, children at this age take their first steps in the process of interpretation in the realisation that pictures have a dual reality; they are objects in their own right while at the same time depicting some other reality. Parson gives a very similar description and refers to this as stage 2; ‘beauty and realism’. Before children reach that stage, however, based on Kellogg’s work, children progress from the scribbles to the Pattern stage, as more eye control is gained; where they start producing Placement patterns as the child responds to the visual stimuli of his/her own scribbling. These tend to be spontaneously drawn as a result of scribbling motions and the favouritism of certain shapes. These formations emerge naturally in the course of the child’s scribbling (Kellogg, 1970).

Age three

At age three the child begins to make definite forms with simple lines (Baynes, 1996) out of certain scribbles. Kellogg identifies these as 6 diagrams (Figure 3.2) defined as ‘definite shapes drawn from an outline’ (Kellogg, 1959:38). After a few months the child starts drawing combines and aggregates. According to Kellogg, the Sun Gestalt is rarely made before 3 years of age and often after which means that when this is present in children’s drawing below the age of 3, they can be considered ‘above average’, ‘standard’ if they are creating them at 3 and ‘below average’ if they are still absent at the age of 4 (Kellogg 1970). This is a stage also identified by Edwards (1993) who names this the ‘stage of symbols’ where circular forms become a universal symbol for almost anything. These are the basic structural marks which children continue to work with (Kellogg, 1970). Kellogg suggests that Diagrams give evidence of planning, deliberation and memory skills.

<table>
<thead>
<tr>
<th>The six Diagrams, Kellogg 1959</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Greek Cross (from scribbles 2 and 3)</td>
</tr>
<tr>
<td>4. Triangle (from scribbles 2, 3 and 4)</td>
</tr>
</tbody>
</table>

Figure 3.2 Six Diagrams by Kellogg (Kellogg 1959:19)
Gesell’s (1947) work involves investigating children’s minds. His work suggests the finding of Kellogg’s and Edward’s work, which note that it is profoundly evident that 3 year old children can create simple shaped forms such as circles, oval and rectangles, but do not have the mental ability to look and recreate (copy) such forms. Cox (1992), however, believed that around this age, children start drawing tadpole figures, meaning that children do start trying to recreate forms. These, according to Cox, usually include tadpole figure by omitting the body form their drawings and having the arms protruding from the head (As described by Kellogg for age 4, illustrated in Figure 3.4).

Between 3 and 4 years old children grow an interest in introducing representational features which are recognised by the adult. This is also a time where the child starts placing only one scribble per sheet of paper (Thomas & Silk, 1990; Lowenfeld & Brittain, 1987). Kellogg noted that after the age of 3, children go into the Design stage where they start producing Combines (2 diagrams joined together in one drawing) and Aggregates (3 or more diagrams joined together) (Figure 3.3). These can appear simpler in appearance than certain basic scribbles made at a younger age, but they are considered to be more advanced developmentally. They show the child’s desire to draw lines in meaningful relationship. Gaitskell (1958) details 10 elements of design: balance, line, mass and space, light and shade, texture, colour, rhythms, movement, unity and centre of interest. At this stage children can include all but light and shade and texture in their drawings. According to Gaitskell, children stay at this stage for about a year, before they start producing drawings with pictorial qualities. This is a belief shared by Kellogg, who believed that drawings of Suns and Radials are the last stages before pictorial drawing. Suns are generally formed as an oval or rectangle shape with short lines along the perimeter. The Radials are a more abstract or non-pictorial Gestalt. A Radial formation is one with lines radiating from a point or a small area. ‘Chimpanzees make the same movements when they are painting with a brush, but do not make a complete radial formation nor do they reach work as advanced as the Aggregates of child art’ (Kellogg, 1970:88).

Kellogg also suggests that ‘the child that has an opportunity to scribble freely and often between the ages of two and three customarily will make many complex Aggregates between
the ages of three and four and will develop a recognisable personal style’ (Kellogg 1970:52).

A definition given by Dondis describes style as ‘the visual synthesis of the elements, techniques, syntax, inspiration, expression and basic purpose’ (Dondis, 1973:128).

Schweizer (1999) worked with older children (14 year olds) and found that children up until that age will match pictures on the basis of content when asked to match pictures on style. However, when the content is controlled, for example all pictures are still-life, the child has no problem matching pictures on the basis of style. According to Schweizer, this indicates that the ability to perceive stylistic differences develops early in children but content overrides stylistic consideration.

Age four

Hope (2008:59) believed from as young as 4 years, ‘some children are aware of the difference between pictures, patterns and text’. This is also the time where children start producing pictorial work, according to Kellogg (1970). The first pictorial drawing children produce is of a sexless, ageless human figure, followed by flowers, animals, boats, houses and vehicles. Lowenfeld shares a similar view and states that this is when the first stage of scribbling finishes, which (s) he considers to be meaningless. At the age of 3-4 years old, Cox (1992) suggests that when children are drawing a human; they are faced with the task of depicting the bulky mass of the head. This is done to distinguish it from the longer shapes of the arms and legs, by resorting to different solutions to represent each body part. Lowenfeld believed that the armless human was the result of the child’s trying to elongate the figure to make it more realistic or that it was an expression of an ‘individualistic emotional state’. After more research he concluded that it is instead implied as a Diagrams or Placement Pattern (Lowenfeld & Brittain, 1987). According to Kellogg, however, the reason children do not add arms on their figures is not due of aesthetic reason nor because they are immature, forgetful or carry any emotional baggage. It is because they find it looks better to them in that form (Kellogg, 1970).

Williams describes how the child uses a region (by which he means an area encompassed by a boundary line) for the head but a single line for an arm or a leg. Figure 3.4 shows examples of typical children’s work when drawing humans. Kellogg states that all different types of torsos are found in older children’s work, but would be considered regressive after age five.

Luquet (1927), who was talking about the development of spontaneous drawings (instead of fixed experimental studies), names this, the ‘Intellectual realism’ stage which he believes lasts until age 6 or 7; 2 years beyond the period Kellogg signifies as the acceptable age for a mentally healthy child. Baynes sees this as a time where the child depicts the salient features of forms by drawing what is known to them rather than what is seen. From a social aspect, this is a time where gender roles develop and children start choosing to play with same gender children. This is something which seems to affect their choice of subject area when
drawing in later years according to Kellogg.

Children go through various stages when drawing human figures, a theme which keeps them interested for many years after they first discover it. For example, the human gets hands and legs before it gets a torso, which is developed in two different ways. The triangle is not usually drawn until the age of about 4½. Much later two triangles are added to make a skirt, fingers, toes, and clothing is added etc. Following the same developmental stages but with a slight difference on the age range, Koppitz (1968) and Cox (1992) believed that children around 4½ year old start adding ears, eyelashes, hair, whiskers, teeth, eye pupils and ‘wings’ when drawing humans.

During this stage children also start using texture in their drawings (Kellogg, 1959). The idea of drawing a human figure-like form horizontally to represent an animal (Figure 3.5) develops, as the child has the mental capacity to see readily what simple changes are required to differentiate the two (Kellogg, 1970). Based on the same idea, of changing basic forms as needed to illustrate something different, Edwards (1993) names this the ‘pictures that tell stories stage’ where 4 to 5 year old children start telling stories and working out problems using this technique.
Kellogg (1970) believed that buildings are drawn from imagination in that age, not through observations and for that reason the houses or buildings made by children in a young age are drawn alike all over the world. She also noted that the first flowers resemble the armless human, which has great resemblance of pre-historic art. Later, transportation drawings such as aeroplanes, trains, cars etc. start emerging. Kellogg suggests that the pictorial labels of these forms are not used until an adult uses them (Kellogg, 1970).

Age five

The stages described above relating to the development of the human figure, flowers buildings etc. are part of what Gaitskell calls the ‘manipulation stage’ which he believes covers ages 1 to 5 years old. He describes this as a ‘valuable time of learning, gaining skills in the use of tools and materials’. This is a process which is repeated every time a new material is given, no matter what the age of the individual (Gaitskell, 1958).

Baynes and Kellogg agree on that up until this age, there are no differences shown between males and females in the capacity to use the Basic Scribbles. Due to cultural influences, children’s choice of subject matter is now affected depending on how it is seen by those around him; ‘masculine’ or ‘feminine’. This is also a time for crisis in child art, according to Kellogg, as child’s spontaneous art is no longer appreciated and is rarely encouraged by the pre-school teachers.

Most often children produce object-centred, (canonical) drawings at this age, as seen from the research conducted with more than 200 children by Hope. Ehrenzweig, however, believes that children have no esthetic awareness until age five, at which time they give up drawing the pan-genital geometric forms and the ‘libidinous scribblings’ (Ehrenzweig, 1965). Gardner (1993), who also gave developmental stages, in regards to cognitive development in aesthetic responses, argues that this is the time of the perception of the inability of others to interpret their drawings as the fault of the viewer develops.

This is also the time of the Oedipus conflict when the child leaves the ‘sublimity and grace of childhood, which is something that affects only boys, according to Kellogg (1970). Yet, based on her research, it was found that the scribblings of young male and female children show no differences. From ages five to seven boys and girls draw certain subjects in somewhat different quantities – planes and boats are more popular with boys, and humans are drawn more often by girls – but before age five, work is the same for both sexes.

At this stage between the ages 5 and six, children can get more adventurous with their drawings, attempting locational drawings of less familiar forms (Hope, 2008). In regards to drawing humans, Kellogg believes that children between 5 and 6 years old might start using
less detail for eye features than before, since as the child matures he favours a simple circle for the eye (instead of also drawing eyebrow, eye lashes, pupil etc.). The construction of the nose however stays the same between ages 5 to 7. When it comes to drawing landscape, Edwards (1993) suggests that children between 5 and 6 develop a set of symbols which are used repeatedly, such as a blue line to represent the sky and a green line for the grass. She refers to this stage as ‘the landscape’ stage.

Gaitskell defines the above stage as the ‘symbolic stage’, recognised by the use of symbols. The age at which this stage begins and end varies greatly according to the author; it could start at 3 until 7, or it might never entirely leave. This stage is characterised by the type of drawings Kellogg names as ‘pictorial work’, where children use fixed symbolic representations for objects, i.e. the circle with short lines around the parameter for a sun, stick men figures etc. according to Gaitskell, this is a stage one needs to overcome if he is to mature as an artist and develop further as relying on these types of symbols may cease to exert them in a search for adequate visual expression (Gaitskell, 1958).

Lowenfeld conducted research by obtaining 40-50 drawings from each age group, totalling up to 400 drawings. The analysis of this work suggested that in this early age visual impressions play almost no part in the drawing, whilst the experience of the body strongly influences the various forms. He concluded that this ‘early infantile mode’ of representation is to a high degree bound up with subjective experiences (Lowenfeld, 1964).

The results from the Bender Motor Gestal test show that as children mature from ages 5 to 11, they can do better copy-work of the test Gestals, though few can complete the test perfectly.

**Age six**

Children focus on drawing humans for many years during their development. At this stage, around the age of 6 years old, children will start growing an interest towards a somewhat more realistic anatomy of the human, adding breasts and phallus. This is something rarely seen before the age of six. According to Gardner, there is a steady rise in the importance of realistic and stylised paintings from this age one which is a view supported by all of Kellogg (1959), Lowenfeld (1952), Schweizer (1999) and Hope (2008).

Kellogg agrees with this view and gives as an example the way that the humans are drawn. In Figure 3.6 we see a double line cross is often used for a torso. ‘Note that arms and legs can be attached to this cross though they cannot be attached to a single-line cross. The Greek cross torso is impressive evidence that esthetic outweighs realism in the work of children under age seven’ (Kellogg 1970).
Lowenfeld suggests the idea that at this age children’s art enter a different phase, calling it the ‘schematic stage’ from ages 6 to 8. During this time the drawings start representing the child's active knowledge of the subject, giving a definite order in space relationships, where everything seems to be anchored on a base line.

![Figure 3.6 Sample of typical human forms drawn by children, Kellogg (1970:163)](image)

Hope (2008) also identified strong new developments in 6 years old children’s drawings, which now start demonstrating ‘a developing sense of colour, pattern, symmetry, even whimsy’ (97) producing viewer-centred (locations) drawings. ‘Children who do not produce canonical drawings within this 4 to 6 years old age band are likely to have development language difficulties’ (101).

Between ages six and seven children start discovering the techniques of graphic and start showing an interest in shape and design (Harris, 1963). However, according to Kellogg, light and shade is not included (1970) nor does it appear in self-taught art.

**Age seven**

From the age of 2 to 7 years old, what Piaget calls the ‘Pre-operational’ stage’ is a period of intuitive thought processes and spontaneous feelings about people and social relations. At this stage the child is highly dependent on the adult for ideas and concepts. Research has so far demonstrated that an ordinary 7 year old child has the capability and sophistication of creating drawings following the style of a certain artist.
Hope (2008) gives an example of a 7 year old student who ‘included pattern making, cartoons and labelled diagrams within his science work’ (97). These demonstrate the wide range of skills and abilities children of this age reach. Gardner agrees with the above view and adds that children are now also aware of how others might interpret their drawings and they will re-draw a picture so that it makes sense to others.

Between 7 to 9 years old the ‘x-ray drawing’ phenomenon begins where children draw things that are not really visible in life. A good example is the drawing of a house, with windows and the front door combines with an x-ray view of the house; a dividing floor panel, lamps hanging from each level’s ceiling, tables, chairs, beds etc. (Thomas & Silk, 1990). As they progress further, overlapped objects, such as a tree partially obscured by the edge of a house, also emerge. The farther away something is, the smaller it will be portrayed, regardless of the real relationship in size between the objects. This indicates a growing comprehension of perspective. In many cases, children have begun using one-point perspective (Thomas & Silk, 1990; Lowenfeld & Brittain, 1987). They do, however still struggle with concepts such as drawing cubes. According to Willats (1995) children up to the age of seven tend to draw a square or a ‘folded-out’ (Figure 3.7) version, a configuration made up of a number of rectangles. Children’s invented solutions to the technical problems of representing the three dimensional world in two dimensional drawings are endlessly inventive (Willats, 1977; Freeman, 1980).

![Figure 3.7 Examples of ‘folded-out’ drawn cubes obtained from this researcher’s case studies](image)

Age eight

It is believed that children, soon after they enter primary school education lose interest in art, as spontaneous art is no longer favoured by the adults. Furthermore, many children have not yet developed their own symbolic representation system to allow them to realistically depict
their ideas, making them feel inadequate. Goldsmith (as referenced in Arizpe & Styles 2003:28), however, believed that around the age of 8 to 9 years old, children start developing the ability to produce internal structures, which might be seen as a stepping stone for their artistic development. Lowenfeld believes this to be the time children become very critical of their work. Kellogg (1970) and Cox (1992) specify that close to this age all spontaneous art activity stops and those who go on usually study and practise intensively to master the techniques of various media. Despite this argument, Kellogg also says that ‘neckless’ (without a neck) humans are still being drawn sometimes at this age. Eye details might start being drawn again (with cubit lips, breasts seen in profile and other details copied from adult’s work). Kellogg (1970) cautions adults not to see these drawings as realistic as they are humans drawn under the esthetic wish to make them look Mandaloid.

Lowenfeld (1964) agrees with the above concept, and names this stage ‘the Gang Stage’ or the ‘Dawning Realism’; which covers the work of 8 to 10 year old children. Children find that schematic generalisation no longer suffices to express reality. Their drawings now have more details for individual parts but are far from naturalism in drawing. Space is discovered and depicted with overlapping objects in drawings and a horizon line rather than a base line. He suggests the idea that the development away from the base line in drawings means that a process of ‘visual perception’ is developing and through the development of perspective, the base line is gradually displaced by the plane. He stated that the ‘order resulting from the criterion of importance plays no part in objective space because it is a subjective measure involving the self (Lowenfeld 1954:41). Wulff (as referenced by Lowenfeld 1959:42) agrees on this view and maintains that the lapse of the base line results in the optical perception that the ground in front of our feet seems to rise. “In this way ‘over each other’ becomes ‘behind each other’.” Once the space perception has developed the base line loses its symbolic nature and makes way for the unified plane. This is also supported by Cox’s (1991; 1992) work. Children at this age still struggle with the technical problems of representing occlusion and perspective while experimenting with recording what they see. Cox’s studies indicated that when children are asked to draw 2 objects overlapping, they will draw them separately. They are representing what they see and know rather than what they can literally see. Freeman (1980) has found similar results and noted that young children (below 8 years old) produced drawings that emphasised known facts about the object, whereas older children could draw objects as they were set in front of them correctly illustrating their viewpoint. Hope (2008) believed ‘that children start from their own viewpoint and only later create powerful generalisations about the world since under the schema’.

Hope went on to say:

‘...it would be expected that older rather than younger children would depict conservational properties such as cups always having handles even if they cannot themselves see them. Surely if children were self-centric at a young age, they would
draw their view of the cups, not an abstracted vision of ‘cupness’ in order to make it clear that the object is a cup not a bowl?” (Hope 2008:100).

Piaget believed that young children are self-centric as they understand things from their point of view and do not have the ability to sympathise with an adult’s perspective, and it is clear that there are some differences of view surrounding this area.

According to Lowenfeld & Brittain (1947) the subjects of the child’s drawings are used as an indicator of when this stage has been achieved as artwork tends to depict the children in a social or team setting as opposed to a more individualised or family focused depiction. However, Willats (1995) has demonstrated that if occluded objects are shown to children in a narrative framework in which the hidden sections make sense to them (for example part of a person hiding behind a wall) they are capable of representing this occlusion in drawings.

Benson (1997:123) and Gardner (1983) believed that between the ages of 8 and 9 the preschooler’s freedom to use form independently of specific content disappeared from the work of most children. Children start drawing using increasing precision, regularity, linearity, concern for detail, neatness and command of geometrical form, but it lacks the liveliness of work completed at an earlier age. Gardner states that ‘it is the pursuit of the realistic and literally true which casts its spell on the individual in middle childhood (1980:142). Arizpe and Styles (2003) are in agreement with the above view. Their research was aimed at children’s understanding and comprehension of images in regards to picture-books. They reported that ‘there is no doubt that the bold, spontaneous compositions of the early years metamorphise into more recognisable, but usually duller representations as children strive for realism as they get older (Arizpe & Styles, 2003: 225-226). They also found that younger children often showed understandings which they were unable to articulate. While Willtas (1995) worked with children, he collected evidence from drawings where straight line objects in perspective were drawn using vertical oblique projections by children up to the age of 9. In general young children found it difficult to draw oblique lines and acute angles in representing solid shapes or structures.

Age nine

The need for realism in children’s drawings of a similar age has also been noted by Edwards (1993) as she calls this the ‘stage of complexity’, were children are concerned for ‘how things look instead of where things are in their drawings’.

Gaitskell (1951) shares the same view as Edwards and describes this as the ‘realism stage’. The author believes that from as early as 9 years old, students enter this stage where they begin to become more critical of their work or express a deep desire to get new knowledge to
help them improve. Similarly, Hope (2008) believes that children start feeling dissatisfied with their drawing output as early as 7 years old. She believes this is so due to the comparison of a range of images they come across to within the new school setting of secondary schools. Gaitskell considers this to be a reaction to their developing ability to see depth and value in the world around them and hence their desire to give their work a greater resemblance to the real thing (Figure 3.8). Gaitskell believes this is the right time for children to begin learning the basics of art such as direct observation from real life.

![Realism stage type of drawing](image)

**Figure 3.8 Realism stage type of drawing**

**Age ten and eleven**

As children enter the stage of 'concrete operations' around the age of 10 years old, children pay more and more attention on the world around them whilst the importance of the self for the drawing decreases. Subsequently, the inflexible human schema starts appearing with an increasing conceptual knowledge of the external world. Piaget found that the development of spatial concepts was complete in most children by about the age of eleven and the map had become a meaningful entity. According to Boardman (1976), by about this age, children have acquired a more stable reference system in respect of qualitative relationships, although they still have not mastered quantitative relationships as evident by their ability to judge distances between objects.

Many authors believe that children lose their confidence in their drawing abilities at a certain age, but not many of them seem to agree on the age or stage this occurs. Lowenfeld believed that this period represents the time at which the confidence of the child in their own creative power is for the first time shaken up by the fact that they are becoming conscious of the
significance of their environment. Kellogg gives a similar description referring to 8 year old children. At this time children get into difficulties over their methods of representing space. Some of them perceive that ‘folding over’ (demonstrated when objects are drawn perpendicular to the base line) is a “mistake”. As the perception of form and size matures, however, the capacity for coordination again increases (Lowenfeld & Brittain 1947).

Edwards (1993) agrees with the above view, calling this the ‘stage of realism’ for ages 10 to 12, and Parson calls this stage 3; ‘expressiveness’, from 10 to 13 years old. They argue that the value of achieving realistic drawing skills teaches them to see deeply and profoundly which helps them gain confidence in their creative abilities. In contrast with Parson’s stage 2, expressive characteristics of non-representational styles can now be appreciated. Individuals come to value pictures for their creativity, originality and for their ability to convey feelings and provide interesting experiences. The same view is held by Gardner (1970) and Schweizer (1999) who sees this as the time where the importance of realistic and stylised paintings decline.

**Age twelve**

Visual experience begins to have a powerful effect at this age, according to Lowenfeld. He names this ‘the pseudo-naturalistic stage’ where the child strives to create ‘adult-like’ naturalistic drawings. Even though Kellogg suggests that light and shadow do not appear in self-taught art, Lowenfeld includes these as new additions in children’s art at this age. Lowenfeld does not specify if this is due to adult intervention or through natural development, even though he did believe the stages he defined were the developmental stages of art in children. He continues by adding that often folds and motion are observed with mixed success, whereas space is depicted as three-dimensional by reducing the size of objects that are further away.

Because the child enters into this new phase of naturalistic drawing, children who feel confident in their abilities usually continue drawing whereas others decide that ‘they can’t draw’ and give up. Swarts (2001) suggests that the drive to development artistically and the behaviour it initiates is not something everyone is born with. He suggests that artistic growth is something moulded by our environment, society and education.

Edwards (1993) agrees with Swart’s and Lowenfeld’s overall position, calling this ‘the crisis period’ and believes that correct teaching can motivate the child to decide they ‘can draw’ and continue developing their skills. Cox (1992) goes into a more detailed description of the process of drawing a human. He observed that children of this age add more details to their drawings of the human figure. In general there is a development from drawing a distinct boundary for each body part to sketching an outline for the whole figure.
According to Piaget this is a period when children first become capable of abstract thought. He calls this stage the ‘operational’ stage and includes children aged 12 and older. Following the same line of though, McNally (1974) described this stage onwards as the time where the children are finally released from the need to relate everything to their immediate environment or experience. They develop in their minds objects which are not physically present. They can thus begin to argue by assuming particular premises and working out their implication mentally. This new way of thinking can be summed up with the phrase ‘the real versus the possible’. The formal thinker proceeds by considering all of the possible relations implied by the data and then attempting by logical analysis to make a judgment as to the truth or falsity of each possibility suggested. This significant stage of development is characterised by three clearly identifiable modes of thinking:

1. Hypothetico-deductive in nature thinking. The formal thinker proceeds by setting up hypotheses to be subsequently tested and either confirmed or refuted

2. Propositional thinking. The formal thinker can follow the form of an argument independently of its concrete content and can manipulate the relationships which might exist, making propositions about the data.

3. Combinatorial thinking. This means that the formal thinker is able to isolate systematically the entire variable in a problem and to consider all the possible combinations.

**Ages thirteen to fourteen**

At this stage the child’s skills are becoming more sophisticated. They can perceive and identify simple linear perspective in surroundings such as different sides of tops and bottoms of any object away from them. They analyse size and position and are prone to use greater details, they can use colour as a perspective tool and understand and use colour harmonies such as monochromatic, analogous, complimentary and others. They start demonstrating qualities in their drawings to exaggerate emotions and action to form a more interesting design and composition (Baynes 1996).

**Ages fifteen to sixteen and beyond**

A more mature artistic side can be seen at these ages, where children use art elements to create emotional relationships, show a more accurate visual relationship of size and position and have a fully developed visual sense of humour (Baynes 1996). This is also a time Gaitskell describes with the final stage of artistic development, which reflects the process used by ‘mature productive artists’ (Gaitskell, 1951). Inventiveness and deeper thought is applied in an effort to make specific statements either defined by themselves or others for creative art, advertising or design.
3.3 Skills and abilities related to developmental stages

Kellogg believes that there is ‘evidence of sequential unfolding of drawing ability' which appears to be identical for all the children and proceeds in a definite fashion (1959:1). Arizpe and Styles (2003:89) agree and state that the development of visual understanding was ‘shown to be linked quite clearly with age’. An example given by Kellogg supporting this are the diagrams which indicate increasing ability to make a controlled use of lines and to employ memory (Kellogg 1970:45). Also, the sun is given as another example, which is very simple in structure, yet it only appears in children’s art after complex aggregates are drawn. This suggests that the ‘structures that children make show developmental sequence which is more than a mere progression from simple to complex line formations (1970:74). This means that detail in drawing does not always reflect a child’s intelligence or the ability to communicate through art, as it is often assumed by teachers and educators. The facts about how children add details to their human schemas are vaguely known but by taking one part of the human at a time, its development can be considered and an evaluation can be drawn on some of the influences that can affect the drawing details (Kellogg 1970:158). Kellogg also believed that the human schemas could be the ideal ‘image’ used to measure the development of the children. She also believed that in child art there is probably a valid sign of general mental development. ‘The child who is capable of perceiving and making Gestalts with increasing clarity may be presumed to be capable of perceiving the world around him with discrimination and purpose’ (Kellogg 1970: 261).

Kellogg also supported the view that the amount of opportunity children have to scribble along with the emotional atmosphere surrounding them while scribbling ‘partially determine how quickly and well they learn all the coordination needed for making the Basic Scribbles’ which are the’ basic markings out of which all subsequent drawing or painting will be developed for the rest of their lives’ (Kellogg 1959:14). She states that ‘the opportunity to scribble freely has meaning for two critical operations of intelligence: reading and writing’ (Kellogg 1970: 262). In addition, she believed that one can decide whether or not the child has the mental development needed for learning to read by using as a guide the child’s art in kindergarten and first grade (Kellogg 1970:118).

Research conducted by Arizpe and Styles (2003) indicated that child art might not represent accurately the reading and writing levels as suggested by a number of authors in Chapter 2 (section 2.4; Graphicacy in relation to literacy). The authors described an interview conducted as part of a research project focused on children aged 4 to 11, with a child described as slightly autistic and registered on the special educational needs list; this student was part of a larger group of participants used for the research. All students were shown picture books and were asked to comment on them. The (slightly autistic) student had great difficulty communicating verbally. His speech was very slow and he had trouble giving a rich description of his thoughts and impressions of the book. ‘His art work’ however, ‘stood out,
particularly in its attention to detail (e.g. the lamp on the post is shaped exactly with pointed pattern on the top, split into two panes and anchored on three triangular-shaped supporting struts). She (the interviewer) was also surprised by the boldness of his line and use of colour, suggesting it reveals a confident, definite use of drawing materials’ (Arizpe & Styles 2003:75).

Through the same study, it was identified that children can identify behaviours and feelings through the use of colours. The size of a character from the book was also identified as giving them the feeling of superiority’ (Arizpe & Styles 2003:86). The children also had no difficulty in analysing most of the visual metaphors. ‘

For example, Browne is clearly making a pointed analogy when he paints a butterfly, perching freely on fresh green grass in identical colours to the tiger, which paces across the parched grass of his high metal cage. This was not lost on some 10-year-olds’ (Arizpe & Styles 2003:87).

Ehrenzweig maintained a theory, derived from Freudian theory, which argued that the scribblings and structures drawn by young children are pan-genital symbols and that the appeal to the child lies in their sexual symbolism. Ehrenzweig arrives at this conclusion through ‘following Freud in assuming that the esthetic pleasure transmuted a sexual (visual or acoustic) voyeurism’ (Ehrenzweig, 1965:258). Kellogg’s experiences of child art however lead her to believe differently (Kellogg 1970:232).

3.3.1 Piaget’s theory of cognitive development in young children

For a long time Piaget’s theory (1959) on age and stages of cognitive development had been used as a basis when creating the school curriculum. Piaget’s theory was based on 4 developmental stages spanning the periods from birth to adolescence.

Stage 1: sensori-motor, describing infancy, from birth to 2 years old.
Piaget believed this to be a period prior to language and logical thought. He believed that it started with the reflex stage, driven by instinctive behaviour and the appearance of the first emotions. Then the first motor activities, organised perceptions and differentiated emotions develop. Lastly the sensori-motor intelligence develops which affects organisation and the first affective fixation with other people.

Stage 2: Preoperation, describing early childhood, ages 2-7 years old.
This is described as a period of intuitive thought processes and spontaneous feelings about people and social relations according to Piaget. At this stage the child was believed to be highly dependent on the adult for ideas and concepts.

Stage 3: Concrete operational, describing middle childhood, ages 7-11 years old. A period of learning from direct experience described by Piaget in a famous phrase as the stage of
'concrete operations'. Children begin to develop moral and social feelings and ideas and begin to be able to co-operate purposefully with others.

**Stage 4:** Operational, describing adolescence, ages 11 years and up, contains the period when children first become capable of abstract thought. At this stage a distinct individual personality is formed and children make effective and intellectual entry into adult society.

High credibility has been given to such theories of developmental stages following Piaget's theory (1959/1971) of child development, as well as hundreds of studies of children's artwork (Feldman, 1999). Simplifying the definitions brings a distinct parallel to Piaget's stages of development. Stage one, the sensory-motor stage, is about the child's development of perception and an understanding of the world; stage two, the pre-operational stage, is focused on a more detailed communication and identification of the world. Stage three, the concrete operational stage, is when children start understanding the permanence of the physical world around them and stage four, the formal operational stage, is when the child begins to approach life and its depiction through different media or dimensions such as creating a three-dimensional object in a two-dimensional space (Swarts, 2001).

Piaget's theory was eventually challenged by a number of academics. Balchin expressed a view which did not support entirely Piaget's theory. He supported that 'visual-spatial ability is liberally present in young children' and it is a natural instinct which should be cultivated and developed into a graphicate ability, unlike Piaget who believed that to be one of the skills which develops naturally. Balchin believed 'that the start of school life is not too early to begin bridging the gap between what the brain can do for itself and what has to be explicitly learnt' (1985:9). Soon after Balchins' 1985 paper was published, Piagetian age and the stage theory was placed under scrutiny by a number of academics in UK and other countries, who carried out work on children's graphic abilities. The developmental psychology perspectives (such as Piaget's theory) have now been challenged and there is a growing body of evidence to suggest that young children's cognitive and spatial developmental competencies have been underestimated in the past (Spencer, Blades & Morsley, 1989; Wilmot, 1999). One example is Matthew's work (1992) describing how the importance of graphicacy in primary education had been re-examined following the advanced, technical and sophisticated programme packages introduced in schools. Also, Boardman (1990:63) concluded that the ability of young children to handle maps had previously been underestimated and in summarizing his findings he said that 'infant school children already have an emerging spatial ability which enables them to show some understanding of place relationships around their home. In addition, young children can learn to use a scale model of a room and follow a simple route on a large-scale plan of their playground.
The 3 main authors’ work most commonly referenced to during this review are summarised in Figure 3.9. Each author’s work is from a different perspective, all very well established within many educational contexts. Kellogg was a teacher and an academic. Her findings are based on years of research and study of thousands of images. Lowenfeld was studying the intellectual and psychological growth and development and how that relates or is reflected through children’s drawings. Gaitskell worked closely with school teachers, and the aim of his research was to provide guidelines for teaching and evaluating students’ art.
Figure 3.9 Kellogg, Gaitksell and Lowenfeld's developmental stages

Kellogg

- Scribbling
  - Labelled Scribbles
  - Scribbles & Diagrams
  - Combines & Aggregates
  - Pictorial work

Gaitskell

- Scribbling Stage
  - Disordered scribbles
  - Orderly scribbles
  - Named scribbles

- Pre-schematic Stage
  - Conscious creation of form
  - Symbols, 1st representational

- Schematic Stage
  - A definite way of portraying an object
  - Everything sits on a base line

- Gang Stage
  - Space is depicted (overlapping objects)

- Pseudo-Naturalistic
  - Attempt to use light, shadow, space, fold & motion, 3-dimensionality,

- Naturalistic Stage
  - Natural development ceases

Lowenfeld

- Manipulation Stage
  - Year 1
  - Year 2
  - Year 3
  - Year 4
  - Year 5
- Symbolic Stage
  - Year 6
  - Year 7
  - Year 8
  - Year 9
  - Year 10
  - Year 11
- Realism Stage
  - Year 12
  - Year 13
  - Year 14
  - Year 15
- Mature Artistic Practice
  - Year 16

- Scribbles
- Organised scribbles
- Scribbles gaining names
- Recognisable objects
- Use of symbols that stand for objects
- Can see depth, form and value like light and darkness
- Explore and express individual ideas
3.4 Other perspectives

3.4.1 Drawing and mark making
The progressive direction and artistic ability of children develops with age. This is a common thread of all of the above theories, although depending on each researcher the period of occurrence of each stage differs. Nevertheless, the direction and order is broadly agreed despite each being attributed a different length of time. Despite the fact that there is a suggested sequence for the development of children, there are also some contradictory opinions. Luquet (1927) supported the idea that children have an internal model from which they extract knowledge when drawing, which in many children appears to be very similar at comparable ages. He also supported that artistic development never develops in one direction or in a constant order due to cultural and educational aspects. Another common view is that children experience some kind of regression phenomena in regards to their artistic development depending on their cultural, social, mental and physical growth (Luquet 1927, Lowenfeld & Brittain 1947).

Riding and Taylor (1976) and a number of authors conducted research to identify if the learning style of each individual develops naturally. His work concluded that the verbal-imagery learning style does not appear to be a developmental phenomenon. Studies with children aged seven and 14 years indicate that at both ages pupils are roughly equally divided between the verbaliser (learn easier through written text) and imager (learn easier through pictorial means) (Riding & Taylor, 1976; Riding & Anstey, 1982; Riding & Pearson, 1981). This does not come in conflict with the previous ideas on the artistic development of children. It does, however, make it clear that for some children, thinking and dealing with images is more natural than others. ‘It seems reasonable to conclude that a pupil performs best on a task when the learning material and the mode of presentation match those of the pupil. When there is a mismatch between learning style and material or mode of presentation attainment is usually relatively poor (Riding & Boardman, 1983:72).

Harris’ (1971) research on children’s basic scribble patterns suggests the above idea. The 20 scribbles identified by Kellogg, which are described as a universal propensity in scribble patterns with the growth of children’s motor skills, were used for this research. Harris found that tendencies differ depending on culture and society, and not on their drawing experience. According to Harris, some native people (the South American Andes Indians, Bedouins from the Sinai Peninsula, and Kenyan children) tend to skip the process of diverse scribble pattern and begin by drawing figures. These are not children who have grown up in highly developed societies with technology and science. They rarely, if ever, use pencil and paper to draw something; rather, they use natural materials, such as sand, rock, and sticks. This is another
example which suggests the argument that aesthetics is strongly influenced by the society and culture. Balchin (1965), Alland, (1983) and Gardner (1994) also believed that it is possible for children to ‘skip’ some of the initial stages (random scribbling, scribbling, simple diagrams etc) if the child did not have the opportunity to create marks at the appropriate age and yet be able to create drawings fitting in the ‘correct’ stage for their age. Having found similar aged children across different cultures creating different types of drawings, Golomb (1992) hypothesised that difference of representation in children’s drawings may come from the difference of aesthetic to which children are accustomed.

Another controversial view exists around children’s abilities concerning the use of style when drawing. Winner (1982) found that children between the ages of 6 to 10 do not have the ability to express mood with colour or lines. He felt children at that age were oblivious to different ways and styles of drawing and felt their drawings were accidently created. According to Edwards (1993), this would mean that children of that age have yet to develop the capacity for full artistic expression. Without relating specific age ranges, Edwards presented the logical progression for a person starting out in artistic expression to be: (1) line, (2) value, (3) colour and (4) painting. She believes that contour drawing of shapes and spaces can teach the use of line. Rendering light and shadows can teach the use of value. The ability to perceive colour as value follows, which is regarded a difficult stage by the author ‘perhaps impossible to acquire unless one had learned to perceive the relationships of lights and shadows through drawing’ (Edwards 1993:xiii). Arnheim (1974) agreed with Winner’s view and claimed that there was no certain evidence showing children using or having advanced intellectual concepts which are needed for abstract thinking of symmetry, proportion or rectangularity. Many authors such as Kellogg (1970), Schweizer (1999), Edwards (1993), Harris (1971), Gardner (1983), Thomas & Silk (1990) and Lowenfeld & Brittain (1987) disagree over this issue of style and emotional expression, as noted in the previous sections.

It is often expressed that too often children lose interest in spontaneous art activities by the age of 7 to 9 years old due to the feeling of disapproval from adults to the child’s type of drawings. Another issue discussed is the effect on children of premature instruction when it comes to drawing. This can happen when adults ask children to describe whatever it is they have just drawn even though the child was just drawing for the sake of experimentation with marks and shapes, or when they draw a schematic representation of something for the child to copy. This is also a problem art teachers come across, as they are often told not to criticise children’s work and at the same time to only compliment drawings done at the ‘correct,’ for that child’s age/stage. Such adult interventions could lead children to copy adults’ objects and figures a few times and then forget it, or become obsessed with making theirs look like that of the adults which interrupts their own natural development. This has led many authors to believe that children can develop a store of knowledge to enable them to reach their final

3.4.2 Children’s responses to images

Developmental differences have been discussed in previous sections relating to outgoing graphicy skills. Research conducted on how children analyse picture-books has found developmental stages relating to incoming graphicy skills. The first stage is concerned with noticing details for which children seem to have very highly developed skills as they often see more details within a picture than adults do. The awareness of critical thinking about cognitive as well as aesthetic factors appears to develop depending on the age of the child. In addition, awareness as an artist and their intentions seems to develop in parallel with age; ‘all children seemed to be familiar with elements like lines, shapes and colours, although they didn’t always have the correct nomenclature’. Kiefer concluded that children seem to grow in understanding the meaning-making power of visual art’ (1993:278-9).

Arizpe and Styles believe that ‘development of visual understanding was shown to be linked quite clearly with age’ (Arizpe & Styles 2003:89), an idea shared by Parsons & Shimojo who believes that children develop from a young age a natural response to the aesthetic qualities of art and notes 5 developmental stages children go through. The first is referred to as ‘favouritism’, ‘an intuitive delight in most paintings, a strong attraction to colour, and a freewheeling associative response to subject matter. ‘…most young children understand paintings at this level’ (1987:22). The authors describe the ability of a child to like or dislike an image. The second stage involves the child’s understanding of other people’s viewpoints as well as his own, a stage referred to as the ‘beauty and realism’ where realism tends to be favoured above other styles of drawing. The third stage is named ‘expressive’, where the viewer’s interest is in the artist’s intention, which develops by provoked feelings due to the art work. The fourth stage, ‘medium, style and form’ signifies a new insight where the ‘significance of a painting is a social rather than an individual achievement. It exists within a tradition, which is composed by a number of people looking over time at a number of works and talking about them’ (1987:24). The fifth and final stage is referred to as ‘autonomy, judgment and dialogue’ which are thought to be the key elements for alert awareness of the character of one’s own experience,’ a questioning of the influences upon it and a wondering whether one really sees what one thinks one sees’ (1987:25).

Using the 5 stages indicated by Parsons, Arizpe and Styles tested to see the ages each stage relates to. According to Parsons, only a small number of well-educated in visual literacy adults can reach the accomplished position of a level 5. The research conducted by these authors has proven that children can fulfil stages 3-5 in many regards (Arizpe & Styles, 2003:48-49). Children in this study found the book with photographic realism equally as
exciting as the one with a mixture of realism and surrealism as well as the non-realistic aspects of the 3rd book (Figure 3.10). ‘Our findings suggest that although children do favour realism as a style of painting, they can find other styles of art equally absorbing and understandable’ (Arizpe & Styles 2003:49).

From the same study, it became apparent that children below the age of 7 found it hard to answer the questions in the interviews and were usually satisfied with seeing things in the text whereas older pupils wanted to pursue the how and why of the artwork’s context. Children as young as 4 years old were able to understand the people’s and animals’ emotions and were able to empathise and show concern for the characters. They were also able to notice connections between the way characters were illustrated to represent a concept i.e. captivity and freedom. In addition, children were able to understand by looking at pictures where the characters were in motion i.e. running, shaking etc. and many children were also familiar with the terms like ‘slow motion’, 3D and ‘pause’. While on film you can easily understand if a person is e.g. angry by their gestures, in pictures, colours and facial expressions are key in communicating such ideas (Arizpe & Styles, 2003:236). The text was not talking about these issues, but the pictures clearly communicated them (Arizpe & Styles 2003:83-4).

Figure 3.10 Three children’s picture books used by Arizpe & Styles 2003

By the age of 7 children were able to provide a simple explanation, linking freedom with happiness and captivity with sadness. By the time they reach 10 years old, children are capable of articulating the visual dichotomy. ‘He is kind of like saying the butterfly is free but the tiger isn’t’ (Arizpe & Styles 2003:88). In one of the books, there was a religious iconography used in one of the pictures of the book, where the image is placed on 4 tiles separated by a white cross. None of the children identified this, a feature which is usually missed out by adults as well (Arizpe & Styles 2003:89).
Research conducted on older students, aged 16 and above (Brumberger, 2011) indicates that familiarity appeared to be an important criterion for judgement when dealing with an image. When showing the students a satellite image, the students who were unfamiliar with such images did not manage to identify the type of image. Furthermore, students were shown images in black and white and were asked to identify the location (country) and at times the time-period the photograph was taken. The author raises the questions as to 'how much of the (wide range of) variation between students’ answers are due to differing levels of visual literacy and how much due to differing life experiences?' The author concludes that the 'digital natives (the students currently populating our classrooms) do not possess a high degree of visual literacy' (44).
3.5 Nature Vs Nurture

3.5.1 Nature

There has been a long debate over the years, on nature versus nurture in regards to artistic development or otherwise the development of skills and abilities in mark making, drawing and the understanding of such images.

Those supporting this development as being of a natural sequence of events believe it to be a system of innate abilities that require minimum energy or external influences for it to develop. Many authors and theories support art making and understanding as a natural occurrence (Arnheim, 1989; Gardner & Lohman, 1975; Gardner 1983, 1993; Golomb, 1992; Kellogg, 1959, 1970; & Lowenfeld, 1954). Malaguzzi (1987) believes that conventional schooling overestimates young children academically whilst underestimating them intellectually.

Dondis stated:

‘... one need not be visually literate to make or understand visual messages. These abilities are intrinsic in man and will emerge, to some extent, with or without teaching or models. As they develop in history, so they develop in the child’ (Dondis, 1973:65).

Hart (1981) observed through research conducted on map reading and cartography (referred to in Appendix 2.2) that the level of spatial organisation in the children's sketch-maps improved as they grew older, indicating the developmental nature of mapping ability. He also found that the further the children explored around their home, the greater were the accuracy and extent of their sketch-map. In agreement with the above, Boardman (1990) stated that children seemed to learn about different environments in different ways and even the youngest showed some understanding of environments beyond their homes (Boardman, 1990).

The findings from Wilmot's research (referred to in chapter 4) also support the notion that spatial perceptual and conceptual development is age related. At the same time, the findings challenge the notion that spatial understanding is dependent on an innate and unfolding process of development which follows an invariant sequence. The results suggest that we may well overestimate and take for granted the child's capacity to structure, organise and communicate spatial information. This finding suggests the claim (Matthews, 1992; Spencer, 1995) that the spatial capacities of children may also be underestimated.

A different view demonstrating the belief that artistic development is natural and not culturally dependant relates children's art work with prehistoric art. It has been suggested that work found through the centuries looks very similar to child art. 'Archaeologists' habits of thought cause them to look for pictorial or symbolic meaning rather than for structures viewed as
esthetic formations” (Kellogg 1970:220-221). Kellogg describes prehistoric art as ‘net patterns’, ‘crosses’, ‘children’s hands’ and ‘rosettes’ (Figure 3.11), all of which are child-art motifs that could have been made by either males or females. She is also arguing over so-called religious symbols found from prehistoric periods such as a simple cross. Other areas which the author believes to have been wrongly identified relate with mythology, culture and customs. ‘Strangely enough the dominant motifs they offer in evidence consist of Gestalts commonly produced by children today’ (Kellogg 1970:212). Fielder is in agreement with Kellogg’s view and suggests that:

‘... children’s Mandalas do not have a religious significance, so far as I can ascertain. I believe that adults have found the Mandala image to be an easy one to use for magical or spiritual purpose because it is a balanced esthetic form and because its origin in personal life goes back to an age when little of what happened is remembered by our conscious mind. The human being is predisposed to the making of Mandalas. This is no more of a mystery than many other aspects of human biology. As Fiedler has phrased the thought, ‘Art is no more extraordinary than other important human performances’ (Fielder, 1979:62).
Lowenfeld, who was in agreement with the theory of nature rather than nurture states;

‘My investigations have shown that the child does not fall prey to an inflexible schema but, using its own individual experience, it creatively transforms the schema in the act of creation’ (Lowenfeld 1954:40).

An example is given where he asked a young girl to draw ‘a man’ for the first time. She went through the already identified initial stages which correspond to younger ages, and then ‘proceeded by a series of jumps to attain the stage appropriate to her age’ (Lowenfeld 1954:19).

This has been seen before, described in section 3.3 taken from Harris’ (1971) work involving native people. In a similar way but focused on a different element of graphiacy, Hart (1981) supported that the level of spatial organisation in the children’s sketch-maps improved as they grew older, indicating the developmental nature of mapping ability. He also found that the further the children explored around their home, the greater were the accuracy and extent of their sketch-map. He also observed that children seem to learn about different environments in different ways and even the youngest show some understanding of environments beyond their homes (1979:58).

Kellogg is categorically against teaching young children the ‘right’ way of drawing by encouraging copy work. She believes that such actions limit the child’s cognitive abilities and slows down their development (Kellogg 1970:100). However, Kress and Van Leeuwen (1996) suggest that at least some help is required to allow this development to occur. In a statement celebrating children’s development they stated how children seem to develop a surprising ability to use elements of visual grammar with little help (Kress and Van Leeuwen 1996). Edwards believes that some skills and abilities develop naturally. After research, she declared that ‘the fifth skill, the perception of the whole, or gestalt, is neither taught nor learned but instead seems to emerge as a result of acquiring the other four skills’. This does mean, however, that the first four components (perception of edges, spaces, relationships and lights and shadows) must be taught before the fifth component can develop (Edwards 1993: xii). Franz Cizek demonstrated that basic art abilities are inherent and develop naturally in childhood, which was later recorded by Wilhelm (1963). *Education through Art* (Herbert, 1945) is furthering the idea that art expression is natural and essential to all children (Kellogg 1970:147).

### 3.5.2 Nurture

Wilson (1992) describes the nurture-based theory best by explaining child art and children’s artistic development as ‘social constructions whose understanding depends as much on the nature of aesthetic theory and interpretation theory as they do on developmental theory’
Furthermore, Eisner (1972) argued that development in children's art 'is not an automatic consequence of maturation but rather a process that is affected by the type of experience children have had and that a child's ability is a function of what he has learned' (105). Cox (1992) is in agreement, and adds that drawing is an artful activity, requiring the mastery of particular techniques which, as in the field of music, even great artists have had to gain and practise (10). Wilson conducted many studies in Egypt, Japan and the United States which have shown that the innate abilities that were believed and relied on in the past may not originate within the child's psyche. Many authors and theories exist to support the above argument. Wilson (1992) suggests that children's art is not inherently creative and untainted but it is directly influenced by the culture in which the child is growing up. Rogoff (1998) believes that children function as part of a multi-layered socio-cultural system as learners, peers and teachers. Kress has pointed out that visual communication is always coded (hence it is cultural dependant), even if it does not always seem that way due to the great familiarity one already has with the code (Kress and Van Leeuwen 1996: 32). Gardner agrees and notes that this is a process starting as young as 2 years of age. Dondis believed that the visual intelligence of abstract elemental composition is possibly the most difficult to describe and may be the most crucial to the development of visual literacy' (Dondis, 1973:14). Turbayne refers to this as the 'metaphors' which humans use to try and illustrate ideas, control the thoughts of others and induce certain types of behaviour in his audience (Turbayne, 1970:3).

In an attempt to ascertain whether mapping abilities might be related to age, general intelligence and maturity of thought, a set of tests was administered by Ghuman & Davis (1981), to 102 pupils aged 12-15 years. The results of this study suggested that older and more mature thinkers, using the criteria adopted by Peel (Peel, 1971), were better at 2-dimensional orientation and appreciation of complex shapes on maps. There was no evidence from this study that age or maturity of thought assisted either with basic map-reading skills or in comparing 3-dimensional images with the map. Performance in all tests was found to depend more on general intelligence than on either chronological age or maturity of thought.

Arizpe and Styles (2003) found a strong correlation between the quality of the children's drawings and the input from their teachers prior to and during a research study:

'...both teachers had clearly influenced the children in the receptive and productive modes, as artists (as the quality of the drawings in those two classes will testify), but also as skilled observers of visual texts. We also noticed that particularly gifted individuals will always buck the trend' (Arizpe & Styles, 2003: 225-226).

Gardner and Lohman (1975) considered the moment in which children begin to understand and use symbolic systems to be a time where human development links with artistic process.
and describes this moment as a ‘resolution’. He perceived this to be a time where a child can invent imaginary objects and events and use them to mediate feelings, experiences, ideas and desires instead of being limited to making perceiving and feeling in relation to material objects and events. He believes this to be an important element and states that ‘making a painting involves acting upon objects and performing motor skills, as well as dealing with a symbolic system of great delicacy; similarly viewing a painting involves consideration of its status as a ‘thing’ in the world, as an attractive object, and as a comment on aspects of the world couched in a symbolic medium. The power and fascination of the arts rests precisely on the fact that individuals become involved with them on both the sensorimotor and the symbolic planes (1975:132).

A study conducted by Wilson and Wilson (1987) over a period of years found that a two-eyed profile (were a face is drawn in profile and yet both eyes are drawn) was drawn as the preferable style from children between the 1880s up until the 1920s and stopped appearing altogether around the time of the 1950s. One belief is that the visual images presented to children from a young age are more likely to influence the child’s personal art than biological tendencies. Gardner agrees and notes that this is a process starting as young as 2 years of age.

Another example illustrating how the world around children can affect their drawing abilities is shown through a different study conducted by Wilson and Wilson (1987). Drawings created by Japanese and Egyptian children were compared with reference to sequential graphic narratives. Japanese children were found to be able to depict idea-laden sequential graphic narratives from a very young age (over 90% of the 5 years old group of children) whereas only 50% of the Egyptian children aged 12 could produce drawings as chronological stories. However, Kellogg believed that ‘the development of child art is independent of associations or social environment’ (Kellogg 1970: 259). In Reggio Emilia in Italy an early education intervention programme (Malaguzzi, 1987) involves practising artists working in ateliers alongside children and their teachers in Pre-school Centres. In the ateliers children are encouraged to develop their intellectual powers through various modes of symbolic representation – role play, recorded talk, numbers and letters, signs and symbols, drawing, manipulating photocopies of icons – and graphicacy is given high status.

Many theorists also believe that the initial act of putting pencil to paper is not out of curiosity, but ‘in imitation of what they have observed an older child or adult to do’ (Cox et al., 1998:71).

Hope suggests that ‘exposure to different drawing genres can enable children to access and exploit these appropriately for different situations’ (Hope 2008:97). Hope also states that ‘children’s drawing skills are far more fluid and adaptable than was once thought but if
children are to access and utilise the many genres of drawing, then they need to be shown how’ (Hope 2008:99).

Avgerinou and Ericson (1997) share the above belief and suggested that children mostly operate in terms of visual literacy at a superficial level which suggests higher order visual literacy skills, which do not develop unless they are identified and ‘taught’. Arizpe and Styles (2003) claim that their research confirmed that children can become more visually literate and operate at a much higher level, if they are taught how to look. Gaitskell (1958) was a firm believer that children should be often exposed to adults’ works of art in order to develop art appreciation and good taste. McFee (1970) agreed with the above views as she advised teachers to expand children’s understanding of the art symbols to help them see richly and aesthetically. She believed that many children use shallow sentimental symbols due to the popular media and should be steered towards fine art by comparing student’s work with that of famous painters.

Cox et al. (1999) conducted a study in China with groups of students aged between 6 to 13 years old. Some of the children had weekend art lessons and some did not. It was evident that the children who had weekend art lessons received consistently higher scores at each age level, which according to the authors suggests that environmental influences, such as instruction, have an effect on the child’s artistic development.

A number of authors have gone a step further, by introducing or suggesting exercises to enhance different elements of graphicacy. A large number of the exercises refer to map reading tasks. One author suggests the analysis of advertising media and another author the analysis of symbols. All types of images suggested deal with symbolic representations.

3.5.3 Analysis of advertising texts

Glasgow suggests the idea of developing the critical skills of visual literacy by using advertising texts. The author believes there are a number of issues needing to be addressed. These include decoding, interpreting and criticising of semiotics which ‘is useful for revealing the subtle cultural messages in advertising’ (Glasgow, 1994:495). These require:

- analytical surface interpretation of the products advertised;
- techniques and appeals employed;
- identification of the deeper meanings conveyed by cultural attitudes and lifestyles.

(Glasgow, 1994:495)
The author suggests the analysis of advertising images should be in writing. According to Glasgow, there can be 4 literal levels of deconstruction:\(^1\):

- **Level 1; deconstruction at the literal level:** A descriptive paragraph giving the initial impressions of an advertisement (Glasgow, 1994:496);
- **Level 2; deconstruction at the inferential level:** Complete examination of the text relating to the secondary or conventional subject matter that reflects the wider culture. As the signified information is being determined from the text and pictures, knowledge of the use of the principles of association and juxtaposition to promote the products is gained. (Glasgow, 1994:497);
- **Level 3; deconstruction at the critical level:** Draw inferences about the ideologies of a given culture in a wider context. History, psychology, sociology and anthropology are used to draw concepts (Glasgow, 1994:498);
- **Level 4: deconstruction at the creative level:** A creative essay should summarise the concepts and themes found while deconstructing at least 5 advertisements in a specific product, idea, or service. Personal response to the advertising should be express, ranging from surface feature considerations to deeper concerns about values and morality (Glasgow, 1994).

### 3.5.4 Enhancing the intelligence of graphicacy elements

In Reggio Emilia in Italy, graphicacy is given a high status by encouraging children to develop their intellectual powers through various models of symbolic representations. These include, amongst others, role play, recorded talk, numbers and letters, signs and symbols, drawing, manipulating photocopies of icons (Malaguzzi, 1987).

Focusing on intelligence enhancement of abstract elemental composition, Dondis has suggested two kinds of exercises:

**Exercise 1** – suggests creating exercises by finding images from magazines or pictures and writings lists of short sentences describing underlying messages, effect, functionality, aesthetic beauty and decorative or entertainment value (Dondis, 1973:19).

**Exercise 2** – Use photographs to enhance the ability to see and create abstract images by using photographs in and out of focus. Use these to create an abstract message, create a symbol and compare how easy it is to draw, in comparison to numbers and letters (Dondis, 1973:84).

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\(^1\) A method of analysing texts based on the ideas that language is inherently unstable and shifting and that the reader rather than the author is central in determining meaning. It was introduced by the French philosopher Jacques Derrida in the late 1960s.
3.5.5 Map related exercises

Boardman recommended that every secondary school should possess copies of the Ordnance Survey maps of the area around the school on the scale of 1:1,250 (50 inches to one mile), 1:2,500 (25 inches to one mile) and 1:10,560 (6 inches to one mile). According to Boardman, the comparison of these maps provides a great deal of information about the limitations imposed by scale and the necessity for selectivity in the representation of features on maps on the more commonly used smaller scales. The reading and interpretation of maps in these larger scales is ideally undertaken by field study followed by analysis of an oblique aerial photograph.

An even more complex perceptual field could be presented by the popular 1:25,000 (2 ½ inches to one mile) and 1:50,000 (replacing the one inch to one mile) maps. In this field consists largely of points (such as posts and pylons), lines (rivers and roads) and areas (fields and factories), in addition to superimposed lettering of various sizes and styles. In particular the representation of the three-dimensional landscape by means of contour patterns presents perplexing perceptual problems for many children.

‘Students might be able to recognise simplified representations of contours patterns when are shown to them in a discrete form, as in a blackboard drawing. The same pupils often experience considerable difficulty, however, in recognising the same patterns when they are present in an embedded form, that is, as elements which have to be extracted from the more complex and confusing contour organisation of the typical topographical map’ (Boardman, 1976:122).

The topographical map, with its numerous and varied contour patterns, constitutes a complex form of cartographic communication (Boardman, 1985). Pupils can be helped to develop a greater understanding of the relief shown on a map by tracing the contours onto separate sheets of cardboard and using the layers as the basis for building a relief model (Boardman, 1986). For a full appreciation of variations in topography, however, there can be no effective substitute for experience gained out of doors by walking across terrain with map in hand (Boardman 1990). In 1990, Boardman also proposed the use of practical map-using tasks similar to ‘find the treasure; in an environment with which children are familiar, to help develop their skills of graphicacy. Boardman also suggested using pupils’ books which contain map extracts and aerial photographs. Adding useful marks on each map to signify the extent of the area covered by the photograph would be a very good exercise. ‘This would not only show the orientation, but also the variable scale of the photograph’ (Boardman 1990:61).

Finson and Pederson (2011:79) list 5 examples of ‘how visual data are important to the teaching and learning in science. They put a lot of emphasis on mental visual modelling (images), analysis and understanding. One example they provide deals with map reading. The authors go through the map reading skills required to understand the map, and extend to
using the information from the map to visualise and understand the terrain. Formulating mental images of models (such as models of the atoms) and interaction with matter (such as compiling information to better understand atomic interaction) are 2 other examples provided. The last 2 examples given include understanding and interpreting graphs while identifying patterns and relations and visualising interrelationships between parts of concepts (concept interrelationships).

3.5.6 Atlas map work

Sandford (1972) suggested a hierarchy of mental processes involved in atlas map work. It was supported that this illustrated the way in which graphicacy overlaps with literacy on the one hand and with numeracy on the other. The hierarchy begins with the:

1. simple perception of symbols on the map followed by
2. the apperception of what it is that the symbols really represent;
3. the use of verbal techniques involving matters such as position, direction, shape, numerical techniques, including the measurements of length, altitude and size;
4. verbal interpretation, which requires reasoned accounts of what can be inferred from the map;
5. numerical interpretation, involving the calculation and expression of data in numerical terms.

3.5.7 Maps and symbolic representations

Balchin suggested very similar exercises and tests as Boardman to help develop some elements of graphicacy. These involve ‘assembling examples of different maps and deciphering what each means. Once the spatial concept has been understood with simple location plans, progress can be made via standard topographical maps with conventional signs to more complex land-use maps. ‘Practical exercises with highway code symbols is another obvious theme which would be of immediate value, as would safety symbols or household equipment’ (Balchin, 1996:6).
3.6 Gender differences

Some controversy exists around the area of spatial and cognitive skills and abilities between genders (some studies related to this matter are reported in Chapter 4). Studies have shown results where girls were underachieving in relevant tests such as map reading, and theories were raised relating to the different strategies used by boys and girls when dealing with such media and their background general knowledge (e.g. Linn and Petersen, 1985). According to Sharkey (1963), boys achieve higher average scores than girls on tests of visuospatial abilities, which involve the perception and manipulation of spatial relationships, such as identifying which of a series of shapes is a rotation of a sample shape. In Boardman's (1990) study, boys’ sketch-maps of their home area were found to be considerably better in spatial organisation than those of girls. Also, differences were found when their spatial activity was categorised according to three parentally-defined ranges of movement from their homes. In all three ranges of movement the limits of spatial range were larger for boys than for girls and the difference in the extent of spatial range increased as the children grew older. The evidence from the children’s sketch-map clearly showed that boys were less constrained in their movements than girls. Boardman reported on the results saying they ‘suggested that map-reading performance depends on the learning style and sex of the pupil and on the type of task’ (Boardman 1990:62).

However, Fairweather (1976) reviewed studies of sex difference in children’s learning and concluded that there was little evidence of consistent differences between boys and girls on school tasks. Arizpe & Styles conducted research on children’s ability to understand picture books (study reported in chapter 4). No differences were found between boys and girls in their early years. As children grow older, the difference between their performances grows wider. Girls tend to pick up more details and elaborate more on their understanding of the picture book (Arizpe & Styles 2003). In a study conducted by Riding and Boardman (1983:77), findings suggested that girls and boys might tackle problems in different ways, or might pay more attention to different elements of the tests, such as map reading, map aerial photograph correlation, symbols translation and view identification. The end results indicated that ‘map reading performance on tasks typical of those learnt in school does not depend on a single ability nor is there a simple overall difference between boys and girls’.

On the other hand, when Pearson (1968) studied teachers’ views on map reading, he noted that teachers in mixed schools thought boys to be generally superior to girls in map work. This is a belief shared by a number of academics (Blair, 1964; Sandford, 1970; Boardman & Towner, 1979). On the other hand, Boardman (1990:57), similarly to the findings of Arizpe & Styles, reports that ‘differences between the mapping abilities of boys and girls exist but are small in younger children’. These increase as children grow older, until ‘by adolescence boys demonstrate more highly developed map skills than girls.’ Sandfords’ (1966) and Charltons’
(1975) findings are in agreement with Boardman, as they found no significance difference between boys and girls (in regards to map reading abilities).

An analysis of variance from Eysenck’s (1965) research (referred to in chapter 4) conducted on map reading indicated two significant results: 1) being field-independent rather than field dependent resulted in better performance on all aspects of map reading for boys but made no difference for girls 2) there was no difference between boys and girls on symbols translation, but on map photograph correlation extravert boys did better than extravert girls, and on view identification ambivert girls were superior to ambivert boys. The results suggest the map reading performance depends on the learning style and sex of the pupil and on the type of task.

The influence of gender is an area that has resulted in clearly defined research outcomes as results of tests have not always been consistent and there are major variances which need to be taken into consideration. According to Riding & Boardman (1983), one reason for these apparently contradictory findings may be that boys are superior on some aspects of cognitive processing while girls are better on others. It is also possible that boys are more susceptible than girls to interference between the external stimulus and their own internal representation of it in memory.

Research on the Swedish Scholastic Aptitude Test (an entrance test to higher education), in which one of the subjects deals with diagrams, tables and maps (DTM) exclusively, has directly or indirectly addressed the issue of factors involved in the interpreting of graphics. In general, the SweSAT, particularly the DTM and DS subtests is characterised by a gender difference in performance in favour of males. In tests measuring general ability however, no such difference is presumed (Halpern, 1992). Obviously, the involvement of a spatial factor, where boys usually achieve better than girls, would be one such plausible source for the deviation (e.g. Halpern, 1994).

Aberg-Bengtsson maintained that this result makes sense, because males are often reported to perform better than females on mathematical factors, and because it may also explain the seemingly strange gender difference reported by Gustafsson et al. With the exception of an end-of-test effect, no other factors were identified despite the fact that a large number of hypotheses were elaborated and tested. However, because the DTM subtest involves a number of different graphic formats, as well as a number of different ways of posing the multiple-choice questions allowing for a range of strategies for the solving of the tasks, this complexity doubtlessly means that a number of intertwined factors are at play. Consequently, although not identified, the existence of a spatial ability dimension cannot be excluded (Aberg-Bengtsson, 1999).
3.7 Summary

The literature discussed a range of stages and levels of drawing and mark making abilities children go through at various ages (RQ 9; what are there main stages/levels of drawing, mark making or other graphicacy related abilities that children go through?). A general understanding of the way children process information at various stages was gained while studying the relevant drawing abilities. This offered a wider understanding of how children learn and develop. Existing knowledge on developmental stages was brought together, covering a range of ages relating to visual literacy. The development appears to be rapid, as clear progression has been noted within approximately every 6 months, starting from infant stage to around 8 to 9 years of age. Some information has been gathered providing a more general progression between the ages of 10 to 16 years and beyond.

The literature review also revealed the limited amount of information which exists at the moment regarding human development and progression in drawing and more specifically childrens’ abilities to create images. Detailed work has been conducted by Kellogg in the 1970s, which describes the stages children go through in drawing, from ages 1 ½ to 8 years old. Other academics and scientists have looked at this in a more generic way, identifying stages covering longer periods of development time (2 years and more). Academics, scientist and other authors have described stages children go through during the years from 11 -14 covering different aspects of development (RQ 10; how does graphicacy capability change/develop during the years of 11-14 years?), but the information found has been rather vague. Detailed work focused on that age range (11-14 years old) could be very beneficial to both educators and the research culture.

Furthermore, skills and abilities related to the developmental stages described in the previous sections are reported according to Kellogg (1970), Arizpe & Styles (2003), Schweizer (1999), Lowenfeld (1964) and Ehrenzweig (1965). Research studies providing evidence on the technical limitations of children’s ability to represent 3D shapes in 2D drawings have been described. Constraints on their ability to represent overlap, acute angles, oblique lines, spatial relationships and scale must inevitably dictate the type of design drawings we can reasonably expect children to produce at the ages of five, seven, nine and eleven years old. This re-enforced the need for this study, as it became clear that not much is known about the outbound graphicacy skills of children in that age group.

The section describing how children respond to images (i.e., picture-books) relates to RQ 8 (are there main stages/levels of drawing, mark making or other graphicacy related abilities that children go through?), as it reports a number of opinions on developmental differences found when analysing and understanding images. Some authors suggest that these are age related.
It is unclear as to where nature stops and nurture takes over through the review. Strong indications are provided however, as many authors agree that around the age of 8 years old children have to ‘make an effort to learn how to draw’, or else they ‘give up drawing’. This might be a primary reason as to the reason developmental stages and progression become very vague around and after that age. However, no empirical evidence has been found to support the above view.

References to incoming skills relating to maps are also made in a later section, where tests and exercises on elements of graphacy were described. Relating to issues around nature versus nurture, some academics have observed that children’s map abilities improve as they grow older, indicating the developmental nature of mapping abilities (Hart et al, 1991; Boardman, 1990). However, Ghuman and Davis (1981) found performance depended more on general intelligence rather than on age. Boardman reported that there is always the possibility that children may know far more about their spatial environment than they are actually able to draw on paper. It was also supported that the importance of the interconnectedness and interdependency of spatial perceptual skills and spatial conceptual understanding are important and should therefore not be underestimated. Consequently, Boardman recommended the use of vertical photograph to be a suitable image for use with younger children as it shows the location of features, its symbolism is entirely pictorial and uses an unspecified scale, with no writing or numerical information (Boardman, 1990). Research has also identified free-recall sketching to be an effective way to help children recall spatial information by a number of authors (Boardman 1990; Matthews, 1985; Hart, 1979).

Exercises to enhance elements of graphacy drawn from this review are focused mainly on spatial abilities. This provides a starting point for answering RQ 8; are there established methods for studying graphacy within the curriculum? This is primarily due to the discipline-perspective of the investigations. Balchin’s (1996) suggestions follow closely Glasgow belief, referring to dealing with semiotic images. Balchin’s focuses his view on a more every day-use of symbols and map reading, which could aid in practical situations. Glasgow on the other hand is taking a broader view, as he is looking in developing graphacy skills through any advertising semiotic images. Glasgow believes that decoding and interpreting semiotics is a very important visual literacy skill, a view shared by many other authors (Wilmot, 2002; Van Harmelen, 2002; Boardman, 1983; Balchin, 1996; Matthews, 1985; Riding, 1979; and others). The author suggests practicing analysis of semiotic images in writing to enhance (incoming) visual literacy abilities. Boardman (1976, 1985 and 1990) and Sandford (1972) suggested a range of map-related exercises, and proceeded in describing these, relating them to relevant levels of difficulty. The concept of contours appeared to be a difficult one for pupils to grasp, and the fact that third-year pupils performed better than first-year pupils suggested that understanding on this matter develops with age.
Through the tests described in this review, a range of examples for future test-designs for graphicacy skills are available. A key realisation drawn from the review was the recognition of strategies of combinations of skills required. Having exercises recommend, suggests that further development of graphicacy elements through nurture is possible.

Gender issues were also investigated. Correlations were made with gender, personality traits as defined in psychology and their verbal imagery learning style. Differences were found between groups but no explanation was given as to which elements of each characteristic is responsible for these. Riding and Boardman (1983) concluded that the findings of their study indicated that map reading performance in tasks typical of those learnt in school do not depend on a single ability nor is there a simple overall difference between boys and girls. This also suggests Willmot's findings which suggest that having a strategy and incorporating a number of skills when working, is a key element to successfully complete such tasks.
CHAPTER FOUR

Literature review (part 3): Graphicacy and students’ learning

Introduction to chapter 4

This chapter is focused on reviewing work relevant to measuring graphicacy or elements of it and using these to measure different human abilities. Section 4.1 provides the literature review research methodology relevant to this chapter’s information. Various elements of graphicacy are listed and described in section 4.2 and reports on existing tests based on children’s art in section 4.3. Commonly used tests within various fields have been chosen for this review, to form as examples (samples) of the existing wide range of such tests. Tests designed to measure graphicacy (section 4.4) and other tests relating to certain elements of graphicacy (section 4.5) are described. Significant interest to the study relates to the specific elements of graphicacy investigated; the methodology used in the tests; the design and execution of tasks; results and their interpretation. A summary is provided at the end, bringing all the key points of the review together for a later discussion (Chapter 8).
4.1 Literature review research methodology

The same search engines were used to gather relevant publication for this literature review as described in Chapter 2. A similar process was also followed in short-listing the potentially relevant publications. The main key words used for this section listed in Table 4.1.

<table>
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<th>Key words</th>
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<td>Image tests, graphicacy test, visual literacy tests, measuring visual literacy, measuring graphicacy, drawing tests, measuring drawing abilities/levels/competencies, interpreting (child) art, visual IQ, spatial-visual intelligence, intelligence, perception, measuring graphicacy/ visual intelligence/ visual communication, tests on graphicacy/ visual intelligence/ visual communication, measuring graphicacy/ visual intelligence/ visual communication, IQ tests, using images to measure intelligence/ skills/ abilities, reading/ understanding images, children’s understanding of symbolic representations.</td>
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Table 4.1 Key words used in the online searches for the literature reviewed in chapter 4
4.2 Skills required when dealing with graphicacy elements

Arizpe and Styles conducted research focused on children aged 4 to 11, investigating their interpretations of picture books in comparison to their reading ability. Their research showed that picture books encourage intellectual growth in children. ‘What made a huge difference to the level of response was children’s previous exposure to a wide range of texts’ (Arizpe and Styles 2003:7). According to Arizpe and Styles, picture books work by reading the text, analysing the picture, re-examining the text and then again the picture (or vice versa). Elements such as motifs, metaphors, patterns and contexts had been explored (Arizpe & Styles 2003:20-23). Very similar views are shared by others. Four stages are listed by Clark (1960) describing the stages of understanding visual work. It begins by the viewer engaging with the text by getting a general impression of the whole before he starts to carefully look at the image. The viewer then connects to his own experience and knowledge which leads to re-examination of the image and finally, how the everyday world had been altered by looking at the image. Similar stages were described after several research studies by Avgerinou and Ericson (1997:286) who gave 4 stages. The first involves the description of the graphic elements composing the image, the second involves analysis of the ways those elements have been arranged, the third includes the interpretation of the messages being communicate and the fourth and final stage includes aesthetic appreciation of the image. Dondis believes that:

‘… the process of composition is the most crucial step in visual problem solving … Many of the guidelines for understanding the meaning in visual form, the syntactical potential of structure in visual literacy, stem from the investigation of the process of human perception’ (Dondis 1973:20).

Hope analysed this position in greater depth and believes that:

‘… a child who has not classified all instances of common objects in his environment as specific instances of these objects and internalised this generalisation sufficiently to produce a canonical drawing of them with reasonable competency by age 5, will probably show signs of language difficulty or will have prompted adult concern in some other way’ (Hope 2008:107).

This author’s work is focused on creating descriptors of continuity and progression stages for different elements of graphicacy. Authors such as Tuckey and Selvaratnam (as cited in Chanlin, 1999) proposed that most visualisation skills can be developed by practice. A number of authors’ work describing spatial conceptual skills, which are part of graphicacy elements, is presented below.

Taking a wider view, Raney’s research is focused on not just drawing, but on constructing a framework of different kinds of visual literacy. Five separate dimensions (out of which the first
is perception as acknowledged by Edwards, 1993) have been identified as described by Arizpe & Styles from the perspective of media education, art and English.

1. Perceptual sensitivity: a basic visual perception available to all sighted people, with the level of sensitivity to vary, shaped by cultural factors that can be deepened by education;
2. cultural habit: the variations which can be accounted for by different cultural practices and historical periods;
3. critical knowledge: understanding of how visual representation is shaped and mediated historically, culturally and artistically and how the viewer is placed in relation to it;
4. aesthetic openness: the capacity for visual delight, concerning with emotional and sensual responses to visual experience which offer immediate access to meaning. It is the experience that colours our ideas;
5. visual eloquence: all of the above integrated in the act of making things to be looked at. This requires a complex mixture of perceptual sensitivity, cultural habit, critical knowledge and aesthetic openness’.

(Arizpe & Styles 2003:41)

Focusing on one element of visual literacy, drawing, Edwards listed 5 essential key skills required while learning how to draw. She believes that anyone can learn how to draw and she guided the reader (in her book ‘drawing on the right side of the brain’) through a number of exercises. These are designed to help the reader understand and acknowledge the basic ‘global skills of drawing’... ‘Drawing a perceived object, person and/or landscape, requires only five basic component skills. These skills are not drawing skills. They are perceptual skills’, listed as follows:

1. the perception of edges;
2. the perception of spaces;
3. the perception of relationships;
4. the perception of lights and shadows;
5. the perception of the whole, or gestalt.

(Edwards 1993:xii)

Archer used the term ‘design awareness’ for design literacy, and described it as art, with two additional elements: the primitive elements, that is the capacity to fashion tools to adapt the environment to suit us instead of adapting ourselves to our environment. Additionally, the capacity to impose qualitative considerations upon quantitative considerations (Archer, 1973).

Moving on to a more specific aspect of visual literacy, a number of definitions are provided for spatial perception. Fisher (1990) describes it as the ‘capacity to perceive the visual world accurately and to recreate visual experience in the mind’s eye’. It relates to how an individual
perceives space. Space is a concept that exists in the mind and permits structuring of relationships between objects in the world. It includes an understanding of words such as above, below, underneath, behind, large etc. Space is believed to be subjective and relative, and depends on the way in which different people structure it at different times (Wilmot, 1999; Boardman, 1983; Spencer et al., 1989).

Archer’s statement is broken down further by Wilmot (1999), by identifying spatial conceptual skills as:

1. categorise and reduce the complexity of the environment;
2. organise, categorise, structure/order and interpret/make sense of one’s perception of what objects are, where they are and how and why they are such;
3. identify, describe, analyse, explain and justify objects and relationships of both a concrete and abstract nature;
4. acquire, organise, store, recall and decode information obtained about the relative location and attributes of objects and phenomena in the external environment, be means of a ‘cognitive map’.

In regards to the third point made by Wilmot, Poracsky et al. believe that seeing is an ‘active art’ to be developed, not a passive experience to be taken for granted, and therefore, improvement is possible (1999).

Following Wilmot’s work, Harmelen & Boltt depicted the spatial perceptual skills in a similar way as Edwards (1993) by describing the abilities comprised within them. Firstly, she stated, ‘to start with basics including the reading of pictures, the manipulation of patterns, shapes, scale, and dimensionality aspects’ are essential (Harmelen & Boltt, 1995:3). Then follows observation, analysis selection, evaluation and synthesis. These include:

1. recognising objects in the environment. This we do through our ability to recognise and identify relationships among shape, colour, size, pattern and texture;
2. recognising the ‘right way up’ of objects: the ability to orientate ourselves in the world and to orientate objects in relation to ourselves and/or other objects;
3. transferring 3-dimensional space into 2-dimensional forms;
4. recognising that real objects are constant in shape, size and colour (perceptual constancy), but that they may appear distorted when represented from unusual views or when transferred into 2-dimensional form;
5. recognising depth and distance/ proximity;
6. identifying perceptions of elevations including vertical/aerial, oblique and horizontal/normal views; and
7. identifying and understanding relationships of location/ position, scale and size.

(Harmelen & Boltt, 1995)
X. Danos Ph.D. 2011                                                  Chapter Four: A literature review (part 3)

Dondis view is similar to the one above, as he considers visual literacy to be a form of intelligence instead of plainly taught information. He lists some visual elements from which;

‘we draw the raw material of all levels of visual intelligence and from them all varieties of visual statements, objects, environments and experiences are planned and expressed’ (Dondis, 1973: 50).

These have been brought together in the list below.
1. the dot: the minimal visual unit, pointer, marker of space;
2. the line: the fluid, restless articulator of form, in the probing looseness of the sketch and the tighter technical plan;
3. shape: the basic shapes, circle, square, triangle and all their endless variations, combinations, permutations and dimensional;
4. direction: the thrust of movement that incorporates and reflects the character of the basic shapes, circular, diagonal, perpendicular;
5. tone: the presence or absence of light by which we see colour is one of the most important and necessary elements in the visual experience;
6. colour: the coordination of tone with the added component of chroma, the most emotional and expressive visual element (Dondis, 1973:50);
7. texture: optical or tactile, the surface character of visual materials;
8. scale or proportion: the relative size and measurement;
9. dimension and motion, both as frequently implied as expressed.

(Dondis, 1973:15-16)

All of the above elements can exist in a drawing on different levels of sophistication related interactively to intend meaning. According to Anning (1997), some of the above elements can be divided between 2 traditions, relating to Key Stages 1-5. In both drawing traditions (through design and technology – training and working practices & through art – fine art) the functions of line, texture, tone, shape and space are complementary but distinctive. ‘Design drawings use line and texture to describe intended outcomes, but the conventions of representing light and space in the search for realism within fine art conventions put an emphasis also on the use of tone and formal devices to represent perspective and scale’ (Anning, 1997:220). Within the secondary school curriculum these two traditions are divided between those responsible for delivering the art and design and the design and technology curricula.

Dondis goes on to say:
‘Colour is loaded with information and one of the most pervasive visual experiences we all have in common. It is, therefore, an invaluable source for visual communicators. In the environment we share the associative meanings of the colour of trees, grass, sky,
earth and on endlessly to where we see colour as a common stimulus. (Dondis, 1973: 50)

Dondis identified 3 possible categories of visual messages each describing the key elements of an image; representation, which is described as a ‘realistic 3-dimensional model’ (Dondis, 1973: 69) which he claims to be the most direct way of reporting visual details of the environment, both natural and made (Dondis, 1973: 82). Another category given by Dondis is ‘symbolism’ which requires ultimate simplicity and the reduction of visual detail to the irreducible minimum (Dondis, 1973: 72). The symbol is anything from a simplified picture to a highly complex system of attached meaning like language or numbers (Dondis, 1973: 83). The third category is ‘abstraction’ which need have no relationship to actual symbol-making when symbols have meaning only because it is pinned on them (Dondis, 1973: 74). According to Dondis these are the primary tools in the development of a visual plan (Dondis, 1973: 82). However, according to Edwards all drawings are the same, broadly speaking.

Dondis also states that the intuitive sense of balance is inherent in human perception in regards to visual patterns (Dondis, 1973: 22). Piaget agrees and states that babies were discovered to identify patterns and learned to anticipate them. This seems to be a spontaneous action, as Balchin believed that ‘visual-spatial ability is liberally present in young children, who often draw pictures and ‘maps’, before they learn to read’ (Balchin, 1976: 191). Another area we unconsciously seek to identify when looking at an image is to recognise regularity or the lack of it. Through leveraging and sharpening we can recognise balance (or the lack of it) and hence recognise the abstract visual condition (Dondis, 1973: 28).

Perkins (1994) describes the qualities a piece of art can offer to a viewer and relates these to young learners starting with the ‘instant access’ obtained from art which is present as one thinks, used as an anchor for attention over a prolonged period of exploration. The other quality is described as the ‘personal engagement’ which involves active engagement with the work of art, stimulating a reaction such as sympathy, revulsion, commitment or persistence. He then refers to the vast variety of symbol systems within art naming it the ‘wide-spectrum cognition’ which involves a multiple sensory modalities such as spatial, pictorial and verbal. Summing up Perkins suggests that art is multi-connected, involving aesthetic concerns, personal convictions, trends of time, social issues and different cultures to create opportunities to bridge thinking depositions across to diverse other context impacts on another.

The UK Associated Examining Board created a GSCE level graphicacy test in the mid-1980s. It was claimed that the test assessed the basic knowledge and understanding of graphic forms of communication which are relevant to people entering the world of work. According to their research and the requirements of the industry employers at the time, the
graphicacy elements considered to be necessary for future employees were:

1. the ability to recognise standard shapes and/or colours of graphical symbols, and
2. the understanding of their significance.

The ability to draw information from memory was not considered to be of the utmost importance and therefore it was not part of the tests. The above areas were tested through the following:

a) signs and symbols commonly used to instruct, advise or warn;
b) information and numerical quantities represented in graphical form;
c) diagrammatic forms commonly used to represent planned sequences;
d) methods of representing three-dimensional objects in two dimensions.

All of the above information regarding skills and abilities required to deal with certain graphicacy elements have been summarised in Tables 4.2a and 4.2b.
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<tr>
<td>Categories of visual messages</td>
<td>Process of composition</td>
<td>Perceptual skills required for drawing</td>
<td>Stages of understanding visual work</td>
<td>Stages of Interpreting picture books</td>
<td>Elements sought when intercepting picture books</td>
<td>Stages of understanding visual work</td>
<td>Art is multi-connected involving:</td>
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<td>Realistic 3 dimensional model</td>
<td>The dot</td>
<td>Perception of:</td>
<td>1. Get a general impression of the whole (engage viewer with text)</td>
<td>1. Read the text</td>
<td>1. Description of the graphic elements composing the image</td>
<td>- Aesthetic concerns</td>
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<td>Symbolism</td>
<td>The line</td>
<td>Edges</td>
<td>2. Start to carefully look at the image</td>
<td>2. Analyse the picture</td>
<td>2. Analysis of the ways those elements have been arranged</td>
<td>- Personal convictions</td>
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<td>Abstraction</td>
<td>Shape</td>
<td>Spaces</td>
<td>3. Connect to their own experience and knowledge</td>
<td>3. Re-examine the text /picture</td>
<td>Interpretation of the messages being communicate</td>
<td>- Trends of time</td>
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<td>Direction</td>
<td>Relationships</td>
<td>4. Identify how the everyday world had been altered by looking at the image (Re-examination of the image)</td>
<td>4. Re-examine the picture /text</td>
<td>3. Aesthetic appreciation of the image.</td>
<td>- Social issues - Different cultures</td>
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<td>Tone</td>
<td>Lights and shadows</td>
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Table 4.2a Skills required when dealing with graphicacy elements
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<td>The dimensions of visual literacy</td>
<td>Describing visual literacy</td>
<td>Spatial conceptual skills</td>
<td>Spatial perceptual skills</td>
<td>Abilities within the spatial perceptual skills</td>
<td>Graphicacy elements</td>
</tr>
<tr>
<td>Perceptual sensitivity; Cultural habit; Critical Knowledge; Aesthetic openness; Visual eloquence</td>
<td>Design awareness: - Primitive elements - Impose qualitative considerations upon quantitative considerations</td>
<td>Categorise and reduce the complexity of the environment; - Organise, categorise, structure/order; - Interpret/make sense of one’s percept of what objects are, where they are, how and why they are such; - Identify, describe, analyse, explain and justify objects and relationships of both concrete and abstract nature; - Acquire, organise, store, recall and decode information obtained about the relative location and attributes of objects and phenomena in the external environment</td>
<td>Manipulation of: - Patterns - Shapes - Scale - Dimensionality Observation Analysis selection Evaluation Synthesis</td>
<td>Recognise/identify relationships among: - Recognise objects, shape, colour, pattern and texture. - Orientate objects in relation to others. - Transferring 3D space into 2D forms - Perceptual constancy may appear distorted when illustrated. - Depth, distance, proximity. - perception of elevations - Location, position, scale, size</td>
<td>- Recognise &amp; understand: Shapes &amp; colours of symbols; - signs - symbols - graphs/charts - diagrams representing sequences - represent 3D objects in 2D</td>
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Table 4.2b Skills required when dealing with graphicacy elements
4.3 Children's art as a mental test

Over the years a number of diagnostic tests such as mental, IQ (Intelligence Quotient), emotional condition and behavioural tests have been developed which use children's art as the means to identify the child's level. A number of different variations of such tests have been developed over the years, from Draw a Scientist to the Draw a Science Teacher test, images are often used to assess intelligence, understanding and perception (Finson & Pederson, 2011). According to Kellogg (1970:189) 'art tests exist because there is a need to assess mental ability 'objectively' before the child is old enough to read'. These tests follow the belief that children follow a sequence of developmental stages and by identifying the stage the child is at, in relation to their age, they can express an opinion on other areas relating to the child’s development. It is believed that children express emotions and thoughts through lines and symbols which cannot be expressed verbally and also that children’s intelligence and personality traits along with their experiences make the lines and symbols unique to themselves. In a recent paper Finson and Pederson (2011:77) pointed out that using visual data is not proven to add anything to the knowledge base and commented that ‘critics speculate … if the images themselves are a valid and reliable source of data’. Gardener has identified a number of different intelligences, and supported that each intelligence develops independently from the others. This contradicts the belief behind diagnostic tests which measures graphicacy (one intelligence) and translates that into a level of competency in another. Unlike Gardner, Goodenough (1926) believed that children’s drawings of the human figure ‘improve’ with age which she thought was due to an increase of intelligence resulting from increased age experience. For that reason, she believed the ‘Draw-a-Man test' measures children's mental capacity.

Initially there were 50 specific details of a drawing completed for a ‘Drawing a Man Test' for scoring and later Harris added 21 more to include all clothing items. Draw-a-Woman test and a Draw-Yourself-Test were also introduced as in the beginning a drawing of a woman had been accepted as ‘a man'. For the child to score a point the item has to be drawn to standards devised by Harris (1963). These tests are used by educators as well as clinical psychologists. Originally the tests were thought to measure not of intelligence itself but some aspect of ‘general intelligence'; one which develops according to child development. In most recent years it is believed that it measures different kinds of mental abilities. Harris suggested it measured children's current level rather than their functional potential.

Harris (1963) suggested replacing the notion of intelligence with the idea of intellectual maturity or more specifically conceptual maturity which he classified as the ability to perceive likenesses and differences, to abstract or classify these likenesses and differences and to generalise or assign an object to a correct class according to its properties. ‘These three
functions are involved in concept formation and a child’s drawing of ‘a man’, ‘woman’, or ‘the self’ will reveal the nature of his concepts about the human male, female and self’ (Harris, 1963:5). He continued by agreeing with Goodenough in that the way a child makes a drawing of a man ‘reveals’ what his mind had perceived and conceived about human males and therefore reveals his ‘intellectual’ or ‘conceptual maturity’ (... as noted by Kellogg 1970:179).

There is much controversy around the validity of the above tests. Eisner (1994) cites a study with two groups of 17 young children in each group. The children were asked to complete the Draw-a-Man test and then for the next 2 weeks Group 1 was given a jigsaw puzzle of a human figure to assemble twice a week before asking all 34 children to retake the test. Group 1 scored considerably higher that group 2. Eisner argued that the test cannot be measuring intelligence since four brief sessions could not have made such an impact. Another example is Griffith’s (1945) work, who found in a period of twenty days that the mental-age scores of one girl aged 3 varied from 3.9 to 4.6 on the Goodenough scale. Kellogg conducted a similar test with 500 children who were asked to ‘draw a man’ each day for five days in one week. About one third of the children got scores which varied as much as fifty per cent.

Some of the arguments around the credibility of the test are based on the small sample of drawings used to ‘standardise’ the work for ages 4 to 8 for the Goodenough tests. According to Kellogg only 119 drawings were used to standardise work at age four. Kellogg believes that ‘the concept of the test is faulty’ (Kellogg 1970:180) and states that ‘being unaware of the whole natural system by which children teach themselves to draw in childhood. Harris makes no allowances in the test for the Gestalts in this natural system, either as assets or liabilities in the scoring process (Kellogg 1970:179).

Hebb (1961) argues that the existing intelligence tests measure mainly the average level of performing or comprehending instead of how good one’s brain and neural metabolism is.

Research in psychology by Lowenfeld suggests the view that there is no need to label child drawings as ‘good’ or ‘bad’ or make value judgement about them. Instead, focus can be placed on the ‘mistakes’; ‘the investigation of which promises to be more fruitful than merely giving them an aesthetic label’ (Lowenfeld 1952:97).

In addition Kellogg suggests that:

‘... conclusions about child intelligence from the (drawings of) humans would be valid only if a ‘drawing test’ takes into consideration the complexities of the esthetic preferences of the child (Kellogg 1970:177).
She also gave an example of where such tests have the potential to fail. Figure 4.1 shows the drawings of an 8 year old boy who achieved an I.Q. score of 80 which placed him in a class for ‘mentally retarded’ students. According to Kellogg this suggests that ‘there is something wrong with the accepted concepts and measurements of child intelligence’ (Kellogg 1970: 200). Kellogg stated that ‘(by) the time the child is old enough to be trained in drawing, a drawing test has lost its usefulness’ (Kellogg 1970:189).

Figure 4.1 Drawing from an 8 year old boy labelled as mentally retarded (Kellogg 1970:200)

On the other hand, Gesell (1947) led the way towards a systematic observation of young children’s behaviours and believed that every child organises their space-world in accordance to specific laws of development. In his research he used drawings to investigate the child mind and came to the conclusion that the mental activity needed to copy shapes is not the same as that which is needed for spontaneous art. Hadamard (1945) claimed that the intelligence shown by children’s art also appears to be related to mathematical learning since without a high degree of aesthetic instinct, no man will ever be a great mathematical discoverer (Hadamard 1945:38).

Most tests of this kind require the child to create one drawing on request which is examined, analysed and scored according to specific criteria. Kellogg believes this practice to be wrong as according to her judgment ‘the esthetic mental images that produce child art would be found to reflect an intelligence similar to that needed for learning to read. If the child can learn to see certain Gestalts in art, he is capable of learning language Gestalts’ (Kellogg 1970:189). There are numerous such tests which follow the same method of accepting the first drawing/ painting for evaluation. One test used claiming to measure emotional disorders is the Human Figure Drawings (HFD) test by by Koppitz.(1984). The Bender Motor Gestalt
Test (1952) is used to measure psychological aspects and the Easel Age scale test (1955) for identifying ‘mentally retarded children’.

Koppitz (1968) used Human Figure Drawings (HFD) to approach and identify emotional disorders in children and suggested alternative ideas in the interpretation of special signs. Koppitz assigned definite meanings to the presence or absence of certain line formations which included 30 developmental items and 30 emotional indicators. Some examples of these are: the exclusion of the mouth indicated feelings of ‘intense inadequacy, resentment and withdrawal’ (Koppitz, 1968:52). Children scoring exceptional on a scale ranging from ‘expected’, ‘common’, ‘not unusual’ and ‘exceptional’ were considered to have above average mental maturity (Koppitz 1968).

The Bender Motor Gestalt Test is a psychological assessment instrument based on the theory of natural development, used to evaluate visual-motor functioning and visual perception skills in both children and adults. The test is an individual test where one is required to copy 9 different shapes shown on cards which are presented to the examinee one by one. According to Kellogg the results of this test show that children can do better copy work of the Gestalts test as they mature from age 5 to 11, though few can complete it perfectly. Psychologists often use this test based on the reliability of the large group of children used to standardise the test (1,104 children) and the short amount of time it takes for it to be completed. As with the Goodenough test, the Bender test cannot be repeated the next day as that would affect the standardisation and give unreliable results. Therefore intelligence is measured by the ability to draw something at the one given time the child is taking the test.

Bender suggests that children ‘like to draw what they see and what is known and their main aspiration is to draw reality as it is’ (Bender 1952:108). Kellogg disagrees with the above statement and questions how one can draw ‘reality’ other than by creating Gestalts which have been accepted to represent objects. What is really seen in life or what is known by each child cannot be identified (Kellogg 1970).

The Easel Age scale is a simple method to evaluate children’s paintings between the ages of 4 to 8 years old. The test was focused on identifying mentally retarded children and their mental age by rating the painting for form, detail, meaning and relatedness and each scale is divided into further categories for each one of the qualities. In the context of the test, form is associated with the developmental growth and the muscular control necessary to portray lines, circles, squares and the shape of common objects such as houses and boats. The test works on the assumption that children record what they have observed about certain objects through their paintings. The test manual says that if a child is persistently painting ‘Q’ pictures
(abstract or non-pictorial images) this could be an unintentional effort from the child to reveal their need for help of a special psychological and/or medical nature.

As with the HFD described by Koppitz, therapists often find hidden meanings based on symbolic representations within child art, and similarly have suggested hidden meanings in prehistoric art structures. For example Machover suggests that bilateral symmetry in drawing denotes compulsiveness; that the ‘right side of the page is considered environment oriented, while the left side is self-oriented’ (Machover 1949:360). Kellogg, however, believes that bilateral art is a dominant category in all human art, of all kinds and of all areas and therefore should be considered normal when expressed (Kellogg 1970:202).

Fry has traced the source of the reaction of all young children to their own scribbling to be an aesthetic one. He says that the pleasure derived ‘from recognition of order, of inevitability in relations’, that is, of ‘pure beauty’, may ‘get its force from arousing some very deep, very vague and immensely generalized reminiscences’ (Fry 1962:228).
4.4 Measuring elements of graphicacy

4.4.1 Existing graphicacy tests

Tests have been developed in relation to general graphicacy for different age ranges and to test some areas or elements of graphicacy. However, only one test has been introduced to test exclusively graphicacy skills: The basic test by the AEB. Most of the other tests identified fall within 4 main disciplines;

1. development of drawing skills and abilities (reported in section 3.5);
2. dealing with quantitative information through graphs and charts. These tend to be conducted within the discipline of mathematics and focus on students’ understandings and misunderstandings of various types of graphs (reported in section 2.4);
3. map and cartography skills and abilities, usually dealt with through the discipline of geography (reported in section 4.5);
4. ‘Graphicacy tests’, as referred by the authors, which most have been conducted in South Africa (reported in section 4.4).

The following section describes a number of authors’ work on measuring elements of graphicacy relating to graphicacy tests and dealing with maps. The literature review based on children’s skills and abilities when using quantitative information based on images such as graphs and charts has not been included. The type and depth of information gathered are similar for the information gathered in dealing with maps. These are interesting and provide ideas to the type of tests one can develop to test various elements of graphicacy. Research relating to maps, and hence spatial abilities has been chosen to be reported on, as important work directly related to graphicacy has been conducted. Table 4.3 summarises the graphicacy elements tested in each test described below.

A Basic Graphicacy test was put in place in 1985 for secondary school children in the UK. After piloting, the Associated Examining Board consulted with a group of educationists and industrialists and put together the Basic Graphicacy Test, to supplement general educational qualifications such as GCSE.

The test covered areas which ‘employers regarded as essential for a very wide range of jobs in different areas of industry or commerce’ (Basic Test Syllabus, 1996:1). The Board defined graphicacy by saying that ‘it embraces all forms of diagrammatic presentation used to communicate information that cannot be conveyed clearly or conveniently by words or mathematical notation alone’ (Basic Test Syllabus, 1996:2). The test (appendix 2.2) covered a wide range of graphicacy elements as identified through the literature (summarised in chapter 2). These include drawings, engineering/technical diagrams, architectural projections, perspective diagrams, exploded diagrams, charts, graphs, symbols, maps and
cartography. This test covered the most areas of graphicacy amongst the entire graphicacy test reviewed in this thesis.
<table>
<thead>
<tr>
<th>Diagnostic tests</th>
<th>ARTISTIC (Pictorial, Graphic arts)</th>
<th>DRAWING (Pictorial)</th>
<th>DIAGRAMS (Pictorial)</th>
<th>CAD (Spatial, Computer Graphics)</th>
<th>SEQUENTIAL (Linear)</th>
<th>SYMBOLIC (Quantitative, mathematical)</th>
<th>SYMBOLIC (Quantitative, mathematical)</th>
<th>TOTAL x24</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEB Graphicacy (GCSE)</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>10</td>
</tr>
<tr>
<td>The shape sorter task</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Puzzle activity 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Puzzle activity 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>The Tangram test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>The Drawing a rectangular box and beaker task</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Drawing a bird’s eye view</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Drawing the school hall</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Drawing a route map</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Table 4.3 Summary of the graphicacy elements tested by Wilmot (2002) and the AEB (1985) tests
4.4.2 Testing elements of Graphicacy

The following was a small-scale (consisting of 16 boys, 10 to 11 years of age), interpretive case study. The research looked at both encoding and decoding spatial information, which according to Wilmot is a paramount skill of graphicacy. Various 10 minutes long practical and drawing tasks were designed to describe and shed light on the ‘spatial skills, combination and level of competency displayed by the children; the difficulties they experienced and the factors which may have enhanced or impeded them’ (2002:328). Data were collected through direct observation, diagnostic activities, field notes and interviews. Teachers’ observations along with verbal and written responses and drawings of the children were gathered. The study was focused on the spatial perceptual skills and concepts associated with graphicacy listed below:

Recognising and understanding:
- Figure/ground organisations: ‘what’ objects are in terms of: shape, colour, size, pattern, texture; discerning objects in the foreground/background and discriminating between objects
- Spatial location and distribution: ‘where’ objects are and how they are arranged; distance, depth and direction
- Spatial relationships: making sense of patterns, orientation, perceptual constancy, and position of object in relation to self and other objects
- Differences between objects in 3D and 2D (on an image) from different perspectives
- What, where and how objects are in space and make judgments about these.

(Wilmot, 2002:326)

4.4.3 Diagnostic tests

Eight different tasks (Appendix 2.2) based on practical (shape sorter, puzzles and the tangram) and mapping (drawing) tasks were created, looking to identify and describe the spatial skills and combinations of skills children utilised in practical tasks (Van Harmelen & Boltt, 1995). The first four tasks were all based on some type of practical activity in which the same or similar spatial skills and combinations of skills needed to be recognised, utilised and applied (Wilmot, 2002:329).

As shown in Table 4.2, the Shape sorter task, Puzzle activity 1, Puzzle activity 2 and the Tangram test do not seem to test explicitly any one of the identified graphicacy elements. It measures hand-eye co-ordination and mental maturation (i.e. identifying and discriminating shapes). Both are important for graphicacy as they are for many other tasks, such as sports, music and in a later stage, writing, amongst others. The speed children complete this with and any planning gone before they start assembling, reflects on the children’s mental capacities. As an example a list is provided with the learning criteria as defined by Wilmot.
The first half of the list gives skills that are directly applicable to graphicacy elements, but in a very general format: working as a team; recognising the relationship between the pieces and the picture on the box; using the latter to guide their efforts; recognising and matching colours; recognising and matching patterns; recognising and matching shape. The other half of the criteria used to assess the student’s in this test are once again focused on hand-eye-co-ordination and mental maturity: concentrating on the task at hand; have good hand-eye coordination; fine motor skills; recognised the skills necessary for the task; understand how best to apply them; understand the conceptual basis of jigsaw puzzle building; understand the concepts of spatial location; understand distribution and relationships.

As the tests progress, they increase in difficulty, and the skills required to completed them approach more distinct graphicacy skills. Puzzle activity 2 (all tests are described in more detail in Appendix 2.2) follows the same thinking as the previous tests. Children have to recognise and use colour and pattern as cues. In the Tangram test, a picture was provided for children to look at as an aid to identifying each piece, which draws nearer to map reading skills where one has to identify and locate features on a map. The drawing of a rectangular box and beaker task is clearly focused on graphicacy elements such as projections (drawing the side view) and still life drawings. Wilmot is looking to identify the key skills required to complete such drawings, in various degrees of difficulty. This is seen by the second drawing students were asked to complete of how the objects would look from a view different from the one they could directly observe. The next test, drawing a bird’s eye view was testing very similar graphicacy skills at a more advance level.

Drawing the school hall required students to deal with Art type of images according to Table 4.2 illustrated above, drawings, perspective and potentially cartography, depending on the approach the student took with the task. The drawings were assessed based on the sophistication and accuracy of the drawing, without providing further details on what these might include or the scale used to assess them. The results did however verify Lowenfeld’s theory of the ‘Gang/social stage’ children go through during this age as ‘most of these children concentrated on showing the shape and layout of the hall at the expense of depth, scale and object orientation in relation to themselves’ (Wilmot, 2002:334).

Drawing a route map required a number of graphicacy skills which are interwoven. In order for one to imagine an area and transfer this knowledge into a 2D drawing of a map, the student also needs to be able to deal with some aspects of perspective and drawing. According to how the student illustrates each feature, it could also include symbols and/or orthographic drawing skills. This seems to be a very efficient way of assessing a number of graphicacy skills within one task, and perhaps a way to start identifying connections between them, i.e. how one can influence the other. The scale of 3 levels of competence used (‘unable to utilise the skill/ utilises the skill with serious difficulty’, ‘utilises the skill adequately’
and ‘utilises the skill in a sophisticated manner’) is a good starting point. For more detailed analysis, each one of the competency level can be broken down to multiple criteria.

Van Harmelen (2002), who worked closely with Wilmot, conducted 6 tests (Table 4.4) which were very similar to the ones described above. The skills tested were also very similar; hence there will be no analytical review for each one of the tasks.

<table>
<thead>
<tr>
<th>Test description</th>
<th>Spatial skills targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involved the use of the ‘shape-ball’</td>
<td>• 3-D to 2-D transference</td>
</tr>
<tr>
<td></td>
<td>• manipulation</td>
</tr>
<tr>
<td></td>
<td>• identification</td>
</tr>
<tr>
<td>jigsaw puzzles</td>
<td>• colour</td>
</tr>
<tr>
<td>simple pictures cut up into a variety of shapes (as used in tessellation activities)</td>
<td>• pattern</td>
</tr>
<tr>
<td></td>
<td>• shapes</td>
</tr>
<tr>
<td>drawing objects as though they were seated on opposite side of them</td>
<td>• Perspective</td>
</tr>
<tr>
<td></td>
<td>• depth perception</td>
</tr>
<tr>
<td>represent objects using a ‘birds-eye’ view of fairly simple objects</td>
<td>Perception of:</td>
</tr>
<tr>
<td></td>
<td>• elevations</td>
</tr>
<tr>
<td></td>
<td>• aerial views</td>
</tr>
<tr>
<td>Reproduce simple still life drawings (of a cube or a ball)</td>
<td>• juxtapose objects</td>
</tr>
<tr>
<td></td>
<td>• represent interrelationships i.e.</td>
</tr>
<tr>
<td></td>
<td>• position</td>
</tr>
<tr>
<td></td>
<td>• size etc:</td>
</tr>
<tr>
<td>the cognitive mapping competencies (Harmelen, Primary Teachers)</td>
<td>• construction of a mental image</td>
</tr>
<tr>
<td></td>
<td>• arial perspective</td>
</tr>
<tr>
<td></td>
<td>• communicate the above in 2D map form</td>
</tr>
<tr>
<td></td>
<td>• Perspective and symbols.</td>
</tr>
<tr>
<td></td>
<td>• spatial comprehensions,</td>
</tr>
<tr>
<td></td>
<td>• spatial cohesiveness</td>
</tr>
</tbody>
</table>

Table 4.4 Van Harmelen, 2002, spatial skills tests
4.5 Map-work related tests

4.5.1 Perceptual reasoning

The problems faced by children in drawing maps were explained by Boardman (1976) in terms of the development of spatial concepts, based on Piaget's (1956) work. Satterly (1964) found perceptual reasoning to be the main problems associated with spatial arrangement and proportionality. He recommended that the pupils should be provided with experiences in which their attention was focused on the spatial arrangements of objects within three dimensions and on their own position in relation to them, as in drawing and model making. Finson and Pederson (2011), focusing on teaching and learning science to pupils aged 16 and beyond, suggested map reading as one of the tools that can be used in the classroom to utilise and gain a deeper understanding of the perceptions that students hold. Boardman's tests as well as others have been summarised in Table 4.5. The tests in the table (described in more detail in Appendix 2.2) are part of a cross-curricular study, focused on the spatial skills of students from the departments of mathematics, science and geography. The study was triggered by poor performance findings related to graphicacy by learners in geography and in geometry. This is an on-going research project; results have not been published yet from this study.

In addition, Boardman supported that certain concepts are included in a number of skills such as looking at an atlas map requires the understanding that the continents are divided into countries, and that each country is further subdivided into counties etc. Related to this is the development of an understanding of the order of magnitude, which enables the children to arrange objects according to size. i.e., appreciate that villages are smaller than towns etc. Children also appreciate symmetrical relationships and that lengths, areas and volumes are constant i.e., two railway connections have the same distance to go from point A-B and return from B-A. Children who are reaching the end of the stage of concrete operations also develop the concept of reference systems. This requires the ability to use two or more criteria each arranged in series to locate a particular object i.e., locate places on maps by means of lines of latitude and longitude (Boardman, 1983).

Boardman’s test is described here as an example of the type of tests commonly applied for map reading and cartography skills. Boardman attempted to provide a class of fourth-year pupils in the lower ability band of a comprehensive school with this kind of experience by means of exercises involving the correlation of oblique aerial photographs with large scale maps. ‘The study of a map of an area which is known to children is generally regarded as a useful starting point for map reading’ (Boardman, 1976:120). Boardman tested these by showing a model of a village to students, and asking them to draw a map of it. This task required students to use:
• a system of reference within quantitative (i.e. distances between objects) and qualitative relationships;
• special correspondence and;
• relate position of objects (left/right, before/behind).

An aerial photograph was taken from a point directly above the clock tower of the school, covering the same area as a single sheet of the 1:1,200 series orientated the same way as the map (north on the top). A line drawing of the main roads and prominent buildings was prepared by placing tracing paper over the print. ‘In doing so they went through the mental process involved in transforming the three-dimensional townscape through the intermediate stage of the oblique aerial photograph to the final stage represented by the vertical plan on the map. Progression in difficulty was attempted by using a second photograph, taken from a higher altitude in conjunction with a map on the next smallest scale. ‘Another difficulty stage would be to change to the orientation of the photograph, i.e. have south east on the top’ (Boardman, 1976:120).
<table>
<thead>
<tr>
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<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive modelling</td>
<td>Map-aerial correlation</td>
<td></td>
<td>Cognitive modelling</td>
<td>Cognitive modelling</td>
<td></td>
<td></td>
<td>3D Cognitive visualisation drawn from 2D map</td>
<td></td>
</tr>
<tr>
<td><strong>Place 3D mental image onto 2D oblique aerial</strong></td>
<td>View identification</td>
<td>Distance</td>
<td>Relate 2D to 3D space</td>
<td>Place 3D mental image onto 2D oblique aerial</td>
<td>Position 3D mental image - location onto 2D surface</td>
<td></td>
<td></td>
<td>Identify 3D to 2D image</td>
</tr>
<tr>
<td><strong>Perspective (oblique aerial)</strong></td>
<td>Symbolisation</td>
<td>Symbolisation</td>
<td>Symbolisation</td>
<td>Symbolisation</td>
<td>Perspective (oblique aerial, plan view)</td>
<td></td>
<td>Symbolisation</td>
<td></td>
</tr>
<tr>
<td><strong>Relationships (quantitative/ qualitative)</strong></td>
<td></td>
<td>Relationships (quantitative/ qualitative)</td>
<td></td>
<td>Relationship (quantitative/ qualitative)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Position (left/right, before/behind)</strong></td>
<td>Perspective</td>
<td>Proportions</td>
<td>Orientation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Proportionality</strong></td>
<td>Separate patterns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Proportionality</td>
<td></td>
</tr>
<tr>
<td><strong>Spatial arrangement</strong></td>
<td>Identify patterns</td>
<td></td>
<td>Spatial arrangement</td>
<td></td>
<td></td>
<td></td>
<td>Spatial arrangement</td>
<td></td>
</tr>
<tr>
<td><strong>Orientation</strong></td>
<td></td>
<td></td>
<td>2D orientation</td>
<td></td>
<td></td>
<td></td>
<td>2D orientation</td>
<td>Orientation</td>
</tr>
<tr>
<td><strong>Disembed a figure</strong></td>
<td></td>
<td></td>
<td></td>
<td>Orientation</td>
<td>Disembed shapes</td>
<td></td>
<td>Perceptual disemboding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Scale</td>
<td>Relative length</td>
<td></td>
<td>Scale</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.5 Summary of skills investigated through map-related tasks and tests
4.6 Summary

A number of authors have described in more depth some of the skills and abilities required to deal with certain graphicacy elements. These have been listed in Tables 4.2a and 4.2b (section 4.2) and illustrated in Figure 4.2. The elements in these tables can exist in an image at different levels of sophistication related interactively to intend meaning.

Research has been conducted around different intelligence and abilities tests which use children’s drawings as a means of measurement. This refers to RQ 4 (looking to identify relationship between ‘graphicacy tests’ and ‘other tests’ such as IQ tests, visual-spatial abilities tests, learning styles tests etc.). Different authors’ opinions on the reliability of such tests are analysed in order to explore the positives and negatives of such practices. Even though no conclusion was reached as to the validity of the tests described, it offers a range of views and interpretations of different quality and sophistication levels of children’s drawings. The discussion on prehistoric art versus child art provides one example of how children’s art can be misinterpreted to have symbolic or other meanings.
Figure 4.2 Illustrated summary of Tables 4.2a and 4.2b
The skills identified by the authors regarding both outgoing and incoming skills relating to elements of graphicy seem to have common core aspects such as symbols and signs recognition, map reading and drawing skills and representing 3-dimensional forms in 2-dimensions. When analysing picture-books and other reading visual material, it was recognised that spatial conceptual skills are fundamental. These were also identified and recognised as essential for tasks relating to creating images and drawings. Collating and analysing the information gathered showed that the skills involved in spatial conceptual abilities are also very similar. This is additional information relevant to RQ 1, as it provides a deeper understanding of what graphicy is. It also relates strongly with RQ 4, which looks to identify existing ‘graphicy test’ or other tests based on the skills of creating images. The report on IQ and mental development tests are also part of the answer to RQ 4.

The methodology adopted by Wilmot when dealing with ‘graphicy’, led to the gathering of information on the skills, abilities and understanding of the students at that specific time-span that the tests were administered (key features of the tests are illustrated in Figure 4.6). The data collection methods included direct observation, diagnostic activities, field notes and interviews, which enabled the researchers to also use their judgment to draw conclusions. This allowed the researchers to draw information on successful and unsuccessful strategies used during the tasks. This is important as it clearly illustrates the complexity of graphicy. Many of the skills and graphicy elements have to be incorporated together along with a broad conceptual framework of the task at hand, in order to complete it successfully.

The list below (Table 4.6) lists the main skills investigated through Wilmot’s and Van Harmelen’s tests which were designed as practical or mapping (drawing) tasks. These were grouped together to give an overall view of the assessment criteria used in the tests. The criteria are divided in 3 categories: spatial skills; areas requiring the noted skills and strategy adopted.

Wilmot’s test offers some levels of competency regarding some elements of graphicy. Of significance to her study was the contention that unless a child has a certain level of spatial perceptual skill competency and spatial conceptual understanding, he or she will battle to cope with the demands of the then new curriculum in South Africa (Wilmot 2002). This forms the beginning of answering RQ 10, indicating how fundamental graphicy is to students’ progress. However, the 3 ‘levels’ stated are very vague. Using such assessment statements might be appropriate for such research but not for incorporating them as goals within the national curriculum for teachers to follow. The statement ‘able to complete the task with apparent ease’ does not define the level of accuracy or sophistication of the completed outcome achieved for each task. It is also important to take under consideration the warnings academics have given concerning the dangers actions such as focusing on level standards might have. Barrow (in Griffinths, 1987:207) alerts us of the hazards of interpreting the word
‘skills’ in a way that leads to ‘a disassociation of educational practice from understanding’, which might lead to a devaluation of understanding, rationality and reason. He also warns of a second danger; that of organising a curriculum based on the development of generic skills rather than on specific forms of knowledge. Griffiths (1987:212) argues that such a view of skills would lead to the introduction of skills to students in a way which ‘reduces them to mindless activities, divorced from theorising and devoid of any serious reflection of any kind’. Instead, the author proposes that ‘skills’ be viewed in the Rylian sense of ‘knowledge how’, which incorporates practical knowledge that sometimes requires very little reflection and at other times requires a great deal reflection (Griffiths, 1987:210).

<table>
<thead>
<tr>
<th>Spatial skills</th>
<th>Areas requiring the noted skills</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand</td>
<td>Shapes</td>
<td>Concentrate</td>
</tr>
<tr>
<td>Recognise</td>
<td>Colour</td>
<td>Teamwork (when available)</td>
</tr>
<tr>
<td>Identify</td>
<td>Pattern</td>
<td>Organised and utilise skills</td>
</tr>
<tr>
<td>Judge</td>
<td>Relationships</td>
<td>Broad conceptual framework</td>
</tr>
<tr>
<td>Select</td>
<td>Location</td>
<td>Identify, discriminate &amp; match</td>
</tr>
<tr>
<td>Discriminate</td>
<td>Size</td>
<td>Recognise &amp; understand</td>
</tr>
<tr>
<td>Match 3D with 2D</td>
<td>Depth</td>
<td>Integrate</td>
</tr>
<tr>
<td>Orientate</td>
<td>Perspective (areal, plan view, side view etc)</td>
<td>Systematic work/ strategy</td>
</tr>
<tr>
<td>Combine</td>
<td>Mental image</td>
<td>Accuracy</td>
</tr>
<tr>
<td>Classify</td>
<td>Transfer mental image in drawing</td>
<td></td>
</tr>
<tr>
<td>Reversibility</td>
<td>Layout</td>
<td></td>
</tr>
<tr>
<td>Rely on memory</td>
<td>Symbols</td>
<td></td>
</tr>
<tr>
<td>Cognitive modelling</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6 Skills and strategies related to spatial abilities

Figure 4.3 was put together while summarising the tests and the analysis criteria in an effort to identify patterns between graphicacy skills and graphicacy elements. A lot of skills relating to graphicacy depicted in Table 4.6 were common between many other authors’ work reported in this review such as to recognise and understand, organise, match 3D objects to 2D images, the use of depth and symbols amongst others.
Figure 4.3 Spider diagram illustrating the key features of Willmot's (2002) test
Much of the research conducted so far relating to graphicity has as primary focus mathematical (quantitative) types of images such as graphs, or geography related images such as maps. This review was focused mainly on ‘graphicity and ‘map-related’ tests. The range of research identified gives some vague indications to how graphicity may appear in teaching (RQ 6) and across the curriculum (RQ 5). In addition, it has provided key features for the development of graphicity tests. These are helpful starting points as well as the identification of elements relating to graphicity which are required before tests are designed to measure continuity and progression descriptors which will form the starting point for beginning to answer RQ 9 (how does graphicity capability change/develop during the years of 11-14 years?).
CHAPTER FIVE

Research Strategy

Introduction to chapter 5

Chapter 5 is focused on describing the research strategy implemented for this research. Section 5.1 lists the research questions along with the relevant sub-questions for each area of focus. After having completed the literature review, each sub-question was rated concerning the extent to which it had been resolved. A summary of those outcomes follows. The strategy followed in search of further evidence for the outstanding questions is then described in section 5.2. The need for a new taxonomy is explained and the strategy developed to provide one is described. A number of taxonomic dimensions are listed and the important, to this study, dimensions are highlighted. The method to validate the taxonomy is also presented. A description is provided of the exhibition used as catalyst over the 3 years to create interest and engagement, and hence facilitating the formation of collaborations. As a result of its potential scope, the main focus of this research lies on prioritising the plans of action while keeping a naturalistic approach. For this reason a number of appropriate methodologies to collect data are discussed. Section 5.3 provides the plan of action for undertaking the research and section 5.4 summarises the overall strategy used for this study. Section 5.5 describes the theoretical perspective of the study over the 3 years.
5.1 Literature outcomes

The literature review served as a tool in identifying appropriate focus areas for this research. The main research questions have been developed from chapter 1 and divided further into a number of sub-questions to enable the area to be investigated in more depth. Table 5.1 illustrates how well each question has been resolved through the review.

<table>
<thead>
<tr>
<th>Research question 1: What is graphicacy?</th>
<th>Well</th>
<th>Satisfactorily</th>
<th>Poorly</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ 1-1 The meaning of graphicacy</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 1-2 Existing terms or words for graphicacy</td>
<td>*</td>
<td></td>
<td></td>
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<tr>
<td>RQ 1-3 Definitions of the above terms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 1-4 The importance of graphicacy</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 1-5 Are there classifications of images relating to graphicacy skills?</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 1-6 Has it been studied in the past?</td>
<td>*</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Research question 2: Has graphicacy across the curriculum been studied before? If so, what were the findings?</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ 2-1 Are there existing studies completed within various academic fields so far, regarding inbound graphicacy skills? (reading and understanding information through images)</td>
</tr>
<tr>
<td>RQ 2-2 Are there existing studies completed within various academic fields regarding outbound graphicacy skills? (creating images to convey information)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research question 3: How can we measure graphicacy?</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ 3-1 Is graphicacy a form of intelligence?</td>
</tr>
<tr>
<td>RQ 3-2 In what forms has graphicacy been measured?</td>
</tr>
<tr>
<td>RQ 3-3 Has it been measured before?</td>
</tr>
<tr>
<td>RQ 3-4 How was it measured?</td>
</tr>
<tr>
<td>RQ 3-5 What ages have been studied so far?</td>
</tr>
<tr>
<td>RQ 3-6 What kind of methodology was used?</td>
</tr>
<tr>
<td>RQ 3-7 Are the findings reliable?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research question 4: Is there an existing ‘graphicacy test’ (or tests) based on the skills for creating images?</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ 4-1 Are there existing graphicacy tests?</td>
</tr>
<tr>
<td>RQ 4-2 Are there other types of test which use graphicacy as the means to measure intelligence or development?</td>
</tr>
<tr>
<td>RQ 4-3</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>RQ 5-1</td>
</tr>
<tr>
<td>RQ 5-2</td>
</tr>
<tr>
<td>RQ 5-3</td>
</tr>
<tr>
<td>RQ 5-4</td>
</tr>
</tbody>
</table>

**Research question 5:** Where does graphicacy fit across the curriculum?

| RQ 6-1 | Which are the most and least popular images used across the curriculum? | * | | | |
| RQ 6-2 | When are images used? | * | | | |

**Research question 6:** How does graphicacy appear in ‘teaching’ (within the sample of schools and subjects studied)?

| RQ 7-1 | Are there certain images that are used in all subject areas? | * | | | |
| RQ 7-2 | Are there certain images which are used only by design and technology or art? | * | | | |
| RQ 7-3 | Are there any common purposes of image-use across the curriculum? | * | | | |
| RQ 7-4 | Do the images usually transfer all required information or do they have to be accompanied by text for them to be useful? | * | | | |
| RQ 7-5 | Which images can stand by themselves with no text and still communicate clearly a message or information fully? | * | | | |

**Research question 7:** What are the main similarities of the use of images across different subjects?

| RQ 8-1 | Is there an established method for studying the way images are currently used across the curriculum? | * | | | |
| RQ 8-2 | Are there established methods for testing/measuring elements of graphicacy? | * | | | |
| RQ 8-3 | Are there established methods on co-research? | * | | | |
| RQ 8-4 | Are there established methods on validating research findings with other experts? | * | | | |

**Research question 8:** Are there established methods for studying graphicacy within the curriculum?

| RQ 9-1 | Are there drawing stages identified? | * | | | |
| RQ 9-2 | What are the developmental stages children go through? | * | | | |

**Research question 9:** Are there main stages/levels of drawing and/or mark making abilities that children go through?
RQ 9-3 Until which age is drawing and/or developmental stages defined so far?

Research question 10: How does graphicacy capability change/develop during the years of 10-15 years old?

RQ 10-1 How much is known about the development of graphicacy during the years 10-15 years old?

<table>
<thead>
<tr>
<th>Well</th>
<th>Satisfactorily</th>
<th>Poorly</th>
<th>Not at all</th>
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</table>

Research question 11: How much is known about the development of graphicacy during the years 10-15 years old?

RQ 11-1 Can students’ progress in any subject areas without the need of graphicacy skills at all?

RQ 11-2 Are there certain subject areas which heavily rely on visual images to convey information?

Research question 12: How fundamental is graphicacy to student’s progress?

RQ 12-1 What is already known in regards to graphicacy and different abilities of children?

Research question 13: Can co-research provide useful data for this research?

RQ 13-1 Can independent researchers work on similar (or the same) areas to collect data in a form that can then be brought together?

RQ 13-2 Can independent researchers work on similar (or the same) areas using already established methodologies and research tools?

RQ 13-3 How much time and effort will be required for a new member to be able to start working independently on the same areas?

RQ 13-4 Do the results justify the above required time and effort?

<table>
<thead>
<tr>
<th>Well</th>
<th>Satisfactorily</th>
<th>Poorly</th>
<th>Not at all</th>
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</thead>
</table>

Table 5.1 Literature review findings against the research questions: an indication of their resolution

5.1.1 Summary of results

Literature review was the first methodology used to gather existing knowledge on graphicacy. The first 4 sub-questions (RQ 1-1 to RQ 1-4; The meaning of graphicacy, Existing terms or words for graphicacy, Definitions of the above terms, The importance of graphicacy) relating to what graphicacy is, were answered very well through work conducted by various experts and academics across the world. The information gathered on the sub-questions RQ1-5 (Are there classifications of images relating to graphicacy skills?) and RQ1-6 (Has it been studied in the past?) helped identify a gap within the
existing knowledge. A taxonomy of still visual images (referred to by the author, Fry (1981), as graphs) for curriculum use was identified. However, as a tool for research within current curricula, Fry's taxonomy was outdated. In addition, a number of other image classifications were analysed. All the information was brought together to give a holistic definition of graphicacy and provide the basis for forming a new taxonomy of graphicacy.

For the second research question, some information was found on existing research conducted on children reading and understanding images (relating to RQ 2.1; *Are there existing studies completed within various academic fields so far, regarding inbound graphicacy skills?*), such as graphs, maps, charts and story books. All the results from the research suggested that the groups of participant children (or students) behaved in certain ways. The samples of participants and length of studies provided mostly qualitative data. Quantitative data were not presented in a way to give supportive evidence establishing age related characteristics of skills and abilities. The outcome for RQ 2.2 (*Are there existing studies completed within various academic fields regarding outbound graphicacy skills?*) was similar to the above. Due to time restrictions, a choice then had to be made between focusing on studying either the inbound or outbound graphicacy skills for this research. As a starting point, studying the outbound skills was chosen. This was based on the potential validity of relevant research methodologies that have emerged from the literature review. Studying the inbound skills would have to be based on verbal and written feedback given by young children (students). Through the literature it was apparent that young children's verbal and written feedback often were not developed enough to allow them to express their full understanding and inbound graphicacy capabilities accurately or fully. Studying the outbound graphicacy skills would have to be based on the student's graphical outcomes (images and drawings). The literature has provided evidence supporting this to be a potentially reliable and valid method of analysis as it is directly related to graphicacy and it can identify the true potentials of graphicacy skills and understanding.

The sub-questions for RQ 3 (*Is graphicacy a form of intelligence?; In what form has graphicacy been measured?; Has it been measured before?; How was it measured?; What ages have been studied so far?; What kind of methodology was used?; Are the findings reliable?*) were formed as a natural progression from the findings collected. A number of studies relating to measuring graphicacy were gathered. The last 2 sub-questions were the most important at this stage. A number of methods, tests and results were gathered. Some were found to be more reliable than others, according to sample size, depth of research and analysis. One test targeted at measuring general graphicacy for GCSE students was identified. That was considered an important finding, as it proved that graphicacy's value has been seen and accepted in the past. Educationalists working with employers from industry discussed some of the key elements of graphicacy required for certain jobs.

In addition, through the answer for RQ 4 (*Are there existing 'graphicacy test' or tests based on the skills for creating images*), a number of tests were found focused on various elements of graphicacy in relation to children of various ages. Furthermore, tests which require the participants to draw certain images
and then analyse these to identify various levels of competency other than graphicacy, were also gathered. Arguments on the validity of various such tests have been noted.

Literature review had aimed to answer the sub-questions:

RQ 1-6 *(Has graphicacy been studied in the past?)*; RQ2-1 *(Are there existing studies completed within various academic fields so far, regarding inbound graphicacy skills?)*; RQ2-2 *(Are there existing studies completed within various academic fields regarding outbound graphicacy skills?)*; RQ3-3 *(Has it been measured before?)*; RQ4-2 *(Are there other types of test which use graphicacy as the means to measure intelligence or development?)*; RQ 5 *(Where does graphicacy fit across the curriculum?).* However the information gathered was not sufficient to form strong evidence. Consequently other research methods were planned to be used as the main sources to obtain the required information. Implicit within this position was the need to establish appropriate research methods to enable the search for how graphicacy is used within the school curriculum.

The way graphicacy appeared in teaching through the literature review relates to the following sub-questions: RQ 1-6 *(Has it been studied in the past?)*; RQ 2-1 *(Are there existing studies completed within various academic fields so far, regarding inbound graphicacy skills?)*; and RQ 5 *(Where does graphicacy fit across the curriculum?).* A satisfactory answer was not able to be drawn from the information gathered. In a similar way, no substantial information was found relating to the main similarities of image use across different subjects. A few references were made to the use of certain images across a number of disciplines within the same subject area, for example biology, chemistry and physics within science. Consequently other research methods would have to be employed as the main sources to obtain the required information.

Looking at established research methodologies, it became evident that for various purposes of this study a number of new methodologies would have to be developed and implemented. For example, in relation to RQ 5, a new research tool would need to be designed to explore where graphicacy fits across the curriculum. In a similar way, a number of other areas would be embarked upon which need further investigation, such as identifying descriptors for various elements of graphicacy i.e. perspective drawing, symbols etc.

Considerable detailed information for some ages was provided on the stages of drawing and mark making children go through. These answered RQ 9 *(Are there main stages/levels of drawing and/or mark making abilities that children go through?)* to a certain extent. RQ 10 *(How does graphicacy capability change/develop during the years of 10-15 years old?)* was similar to RQ 9 in content, but it was specific to an age range for which insufficient information was found. The lack of detailed information after the age of 6 helped define the focus of this research.
RQ 11 *(How fundamental is graphicacy to student’s progress?)* was focused on the importance of graphicacy in students’ learning. This has been identified as an area which needs significant research to be completed, as the information gathered was minimal. Further research would have to be completed following alternative research methods in order to answer this question satisfactorily. RQ 12 *(Is the potential offered by graphicacy fully exploited for the learning of all students?)* was clearly seeking to identify if the potential offered by graphicacy has been fully exploited for the learning of all students. Only a small amount of information was gathered, and that was subject specific, for example relating to geography or mathematics. At the beginning of this review, a large amount of information was expected to be located, setting a strong foundation from existing work related to graphicacy and how it can affect students’ learning. The results, however, have indicated how little research has so far been conducted on this area. Even less information was identified for RQ 13 relating to the research method of co-research. This research is about pursuing well-defined data gathering routes that others can replicate. Co-research is in one sense always a goal when pursuing research. However as a consequence of the magnitude of the research task required, this methodology needs to be designed in a way not only to allow replication and validation of the findings, but for individual researchers to collect new findings in a way that can be collated with the findings of this study. Collecting data from different students coming from different backgrounds would not have any negative effects for this study as levels of competency were not a current requirement or an area of interest. The focus of the research at this time was on identifying descriptors of understanding and competence in various elements of graphicacy which can define continuity and progression. Consequently, appropriate strategies and opportunities for co-research would have to be identified, designed, piloted and tested within this research programme.
5.2 Background and Strategy

In order to fill in some of the gaps left by the literature review, a number of other research methods and strategies had to be designed and implemented. The first area for research completed through the literature review was focused on RQs 5 and 7 (Where does graphicacy fit across the curriculum?; How does graphicacy appear in ‘teaching’ (within the sample of schools and subjects studied)?; What are the main similarities of the use of images across different subjects?).

In order to answer the above questions, RQ 8 ‘Are there established methods for studying graphicacy within the curriculum?’ had to be tackled. Identifying graphicacy across the curriculum would require the use of a research tool, clearly defining graphicacy. A number of existing taxonomies of images (called diagrams by the authors, Blackwell and Engelhard; 1998) were identified for the study of diagrammatic representations through the literature review. A significant diversity in taxonomic analyses of diagrams exists; proposing 6 taxonomic dimensions shown in Table 5.2. Blackwell and Engelhard encouraged the development of more taxonomies to be developed for specific purposes. The ones closest to the study proposed above include: the selection of representations for educational contexts (Dale, 1969; Goldsmith, 1984; Cox and Brna, 1995) and related to cartography, typography, and graphic design (Bertin, 1981; Twyman, 1979; Richards, 1984; MacDonald-Ross, 1977; Garland, 1979; Van der Waarde, 1993; Engelhardt 1998).

<table>
<thead>
<tr>
<th>The representation (the graphic display)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 The graphic domain (graphic vocabulary)</td>
</tr>
<tr>
<td>1.2 Graphic structure (visual/spatial relations)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The message (the represented information)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 The information domain (ontological categories)</td>
</tr>
<tr>
<td>2.2 Information structure (relational properties)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relation between representation and message</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Pictorial correspondence (realistic/abstract)</td>
</tr>
<tr>
<td>3.2 Analogical correspondence (structure mapping)</td>
</tr>
</tbody>
</table>
### Task and process (interpreting and modifying representations)

| 4.1 | Information processing (perception and problem solving) | In a taxonomy that considers how the diagram is used (a science of thinking-with-diagrams rather than simply a science of diagrams), the processes of construction and interpretation must also be considered. Some of these processes are "internal" cognitive processes, while some appear to depend completely on physical devices or tools. In fact, processes of diagram use form a continuum of physical and cognitive operations which is divided only at the peril of the taxonomist. Some taxonomies emphasise particular portions of this continuum (ergonomics, or mental reasoning), but we include them all here. |
| 4.2 | Tools (interaction with the representation) |

### Context and convention (cultural and communicative context)

| 5.1 | Communicative context (roles in discourse) | The way that we interpret depictive conventions depends on cultural context as well as the conventions of particular media types. |
| 5.2 | Cultural conventions (society and representation) |

### Mental representation (diagrams in the head)

| 6.1 | Mental imagery (nature of internal representations) | Mental representation and the static properties of mental representations. |
| 6.2 | Interpersonal variation (differences between people) |

Table 5.2 Taxonomic dimensions provided by Blackwell and Engelhardt (1998:2-3)

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A taxonomy not mentioned by Blackwell and Engelhardt was Fry's taxonomy of graphs (1974). According to its originator the taxonomy was designed to be useful for teaching and testing graphs knowledge in the government-funded schools and in helping writers and readers in many communication media, including journals, textbooks, popular press, computer graphics, and television.
5.2.1 The need for a new taxonomy

Fry's taxonomy (1974) was the closest one identified relating to the research tool needed for this study. He published a wide-ranging taxonomy categorising images according to the type of information represented, i.e., quantitative, spatial, lineal, etc. He illustrated examples probably following the images most commonly used in academia at the time. As times have moved on, the Internet has emerged, and computer drawing tools have become more common in schools, the nature of drawing within the school curriculum provision has changed, i.e., use of colour, photographic, and 3D images. Hence, there was a need for an updated taxonomy. The new taxonomy was required to serve as a research tool to map graphicacy, and ultimately to support the identification of the skills and abilities to communicate through visual images. To achieve these goals, the categories had to be organised so as to accommodate all types of images, grouped according to the different types of understanding one requires to be able to create or read and understand these. For example, symbolic representations such as maps and symbols use colours, shapes and lines and other elements to represent ideas and allow comparisons between features to be made. This new taxonomy had to be a modern, cross-curricular framework which could be used to explore graphicacy across all years of secondary education.

5.2.2 Strategy to develop the new taxonomy

The taxonomy was to be developed through five stages:

- Developing categories from the literature review;
- Identifying associated outbound and inbound graphicacy skills;
- Visually representing the emerging concept of graphicacy;
- Articulating the meaning of the main categories; and
- Defining the new taxonomy of graphicacy.

It will be formed in a way to help teachers from different subjects to identify where graphicacy is used during their teaching as well as in other subject areas.

Each one of the categories will be representing types of images that require specific kinds of skills in order to be read, understood, and created. Terms from Fry’s (1974) taxonomy will be taken where they still seem appropriate to help accommodate the updated categories.

5.2.3 Taxonomic dimensions

The taxonomic dimensions described by Blackwell and Engelhard are used as headings in Table 5.3 against all taxonomies relevant to graphicacy skills or educational research. The table has been modified from its original form to include the taxonomies by Fry (1974) and Danos (2009, the new taxonomy).
Table 5.3 Relation to existing taxonomies.

Refer to Table 5.2 for the description of each taxonomic dimension mentioned in the table above e.g. ‘1.1’ is ‘the graphic domain (graphic vocabulary)’, 1.2 is ‘Graphic structure (visual/spatial relations), which describe the organisation of the display - distribution of ink and colour. It tends to identify different components, and their relationships’, etc.

5.2.4 Validating the taxonomy

The taxonomy of graphica is considered to be a work in progress. The taxonomy will be tested prior to its use through discussions with a number of independent researchers. The results of its piloting will provide further validation, but it will also be presented at conferences and discussed with academics, researchers, active teachers and other professionals. It will also be published in a national design magazine, and in a number of international conference publications. Finally, the taxonomy and the results obtained through its use will be subjected to scrutiny by leading researchers in this area through a Delphi study.
5.3 Designed approach

5.3.1 A catalyst for collaborations

A strategy was required in order to create interest and engagement from schools to allow the research to be undertaken. It was decided that ‘The Quick on the Draw’ exhibition had potential to act as a catalyst during this time, and consequently it was used to develop a number of opportunities for various stages of the research. Loughborough University hosted the exhibition, set within what was then the Design and Technology Department. PGCE mentors’ meetings, usually held in the department, could be organised to take place in the exhibition area. An expected number of participants would be between 25 to 30 mentors from a number of schools. This would offer an opportunity to present the idea of graphicacy to a number of pro-active teachers.

Future goals for this research included the need to:

- Form a collaboration with a school to be used as the base for most of the research within practice to be conducted in the UK.
- Form a collaboration with a school to participate in a workshop, as part of a pilot study designed to establish progression descriptors of continuity and progressions for 3 elements of graphicacy.
- Form a collaboration with a PGCE design and technology department from a University. This would aid in a number of areas where further research development and validation of results was required, such as exploring: the taxonomy as a research tool through exercises and tasks; the methodology created for drawing progression descriptors through individual research; the methodology on mapping graphicacy across the curriculum; and the methodology developed for co-research.
- Publish an article in the ‘Designing’ magazine (Punter & Whitton 2009); a national design magazine distributed to most design and technology departments in England. The article would be focussed on graphicacy, the exhibition, and their connections. The article would have as a focus informing and inspiring teachers on the importance of teaching and learning graphicacy.
- Form collaborations with the University of Cyprus, the Design and Technology Teachers Association (of Cyprus) and the Government Office of National Curriculum Development (of Cyprus) using the Quick on the Draw exhibition as a catalyst. Funding would be raised in order to send part of the exhibition to the University of Cyprus. The rest of the exhibition could be re-printed and mounted in Cyprus. The exhibition could then be once again used as a catalyst to organise an event for an evening in the Ministry of Education of Cyprus. The taxonomy could be presented along with the methodology developed to draw progression descriptors of graphicacy elements and some of the initial results.

The other half of the exhibition was sent to the University of Limerick in Ireland to accompany an IDATER Online Conference concerning Graphicy and Modelling. This was to provide an
opportunity to present some of the research findings and further validate the taxonomy. The part of the exhibition that remained in Cyprus would be provided in a digital form.

The exhibition was also to be developed fully in a digital form before it was sent to Cyprus. This would enable future use of the exhibition as a catalyst for generating interest in the research i.e. in an international conference presentation concerning the taxonomy and the cross-curricular analysis of textbooks, in August 2010. One of the outcomes of these presentations was gaining the interest of a number of academics (e.g. professors from the USA, Israel, Cyprus, USA and Sweden) in participating in a Delphi study.

To enable the above to take place, a number of research methods would have to be developed. These included:

- Analysis of textbooks to map graphicacy across the curriculum (relating to RQ 5 Where does graphicacy fit across the curriculum? RQ 6: How does graphicacy appear in ‘teaching’? and RQ 7: What are the main similarities of the use of images across different subjects?)

- Workshop-based lessons with specifically designed tasks and exercises to enable graphicacy descriptors to be established (relating to RQ 3: How can we measure graphicacy?; RQ 8: Are there established methods for studying graphicacy within the curriculum?; RQ 9: Are there main stages/levels of drawing and/or mark making abilities that children go through? and RQ 10: How does graphicacy capability change/develop during the years of 10-15 years old?)

- Lectures, workshops and seminars to pilot co-research and validate research methods and results (relating directly to RQ 8 and RQ 13 Can co-research provide useful data for this research? and indirectly, to RQs 5, 6, 7, 9, 10).

5.3.2 Case studies: Cross-curricular analysis of textbooks

According to Stake (1995) a case study method is well suited to rich interpretation and thorough understanding, the goal of which is to understand the case rather than to seek to establish generalisations about the wider population to which the case belongs. The Investigation of graphicacy use across the curriculum will be designed to answer RQs 5, 6 and 7. No restrictions will be made on the cultural focus of the study. This freedom will allow the study to expand within different countries and cultures. Even though this is not a primary focus area, opportunities will be sought to extend the study over different countries, to attain an indication of whether graphicacy use is different between countries. Through a personal friend and teacher from Cyprus it might be possible to form a collaboration with a secondary school in Cyprus. Again through a personal contact, a school in the USA would be sought to form a collaboration allowing the research to take place through interviews, questionnaires and/or textbooks’ analysis. It was hoped that the collaboration with the school in the
UK might transpire as a result of the Quick on the Draw exhibition and the presentation made to PGCE mentors.

5.3.3 Research within practice

The following graphicacy elements (Table 5.4) will be researched during research within practice. These are defined and explained in more detail in chapter 6.

<table>
<thead>
<tr>
<th>Area of focus</th>
<th>Graphicacy element</th>
<th>Food Technology lesson (Year 7)</th>
<th>Curriculum day (Year 7)</th>
<th>Workshop (GSCE students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star profile</td>
<td>Charts and graphs (Symbolic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portraits</td>
<td>Portraits (Western art)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logo design</td>
<td>Symbols (Symbolic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perspective</td>
<td>Perspective (Diagram)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rendering</td>
<td>A basic skill for a number of graphicacy elements</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.4 Research areas of focus

5.3.4 Co-research

The initial pilot studies on defining continuity and progression descriptors will be focused on bringing to the surface the time requirements and dedication needed to draw accurate and detailed results. For this reason, only a small number of graphicacy elements will be looked at by this author. These will be chosen according to the requirements of each group of students participating in the research. Nevertheless, the possibility of working with other researchers in order to investigate some of the areas will be considered if it is deemed appropriate. The areas to be studied using this method will be chosen according to the possibilities available at the time, if a co-research partnership developed.

Co-research would offer the potential of enabling more types of images to be investigated alongside the research conducted for this study. Working with other researchers while still focused on this study would have the advantage of being able to help and guide the researchers when needed. This would be necessary in order to allow co-researchers to produce reliable results in a form that could be used and collated with this project. PGCE students would be targeted for co-research since they are required to undertake action research as part of their teacher training programme. Experienced secondary school teachers as well as trainees will be informed about co-research through the 2010 Design and Technology Association Conference. Workshops will be expected to ran in 2010-2011 to allow for more potential co-research collaborations.
In addition, future co-research could be organised to gather data on graphicacy within school curricula as well as to facilitate graphicacy audits. Future plans for further school involvement nationally and internationally are illustrated in Figure 5.1. Through such a scheme, statistically determined levels could be established if co-research could be demonstrated to be effective. This can be based on either teachers’ experience or expectations, or from actual results taken from students’ work.

Figure 5.1 Co-research: gathering information collectively

Researchers will have the opportunity to use the methodology developed so far to collect the information required, or alternatively use a different or new methodology which can be adopted and designed to provide results in a form that can be collated with the existing work. However, a full and clear understanding of this author’s present position, aims and goals is essential in order to provide usable material for this research.

5.3.5 Delphi study

The Delphi group study will be designed to challenge the findings and methodologies used in this study by experts on the field from Europe and the USA. Having such a large research area to study, it was considered important to confirm the methodologies designed and implemented, as well as the validity of the results. One area of interest would be described in each round of discussions and a number of relevant questions set. Participants’ responses were to be collected and collated, and relevant actions would be taken for each point of discussion raised.
5.3.6 Implementing the research strategy: workshops

The following are workshops to be planned in order to conduct the research.

Research within practice

- A school visit of 24 GCSE students at the Quick on the Draw exhibition, 2010. Following research within practice, the methodology developed to collect information of students’ existing knowledge, the understanding gained during a lesson and their knowledge subsequent to the lesson will be tested. Information for 3 graphiacy elements will be gathered, which is part of the methodology for establishing graphiacy descriptors.

Co-research and inter-rater reliability

- A lecture and workshop with approximately 80 PGCE and MA level students at Sheffield Hallam University 2009. The inter-rater reliability of the taxonomy will be tested. Co-research and the area of this study will be introduced.

- PGCE seminars 2010 at Sheffield Hallam University. Aspects of co-research will be tested.

Validation of the proposed research methodology

- Approximately 35 academic researchers will take part in an exercise and discussion focused on the inter-rater reliability of the taxonomy. The workshop will use as an opening for the Design and Technology Association Education and International Research Conference in 2010. The concept of co-research will be also presented and then discussed.

Piloting of research methodology

- A workshop testing the methodology for a case study, designed to run for a full school day, will be conducted. Five university students will take part in a 5 hour workshop on portrait drawing. The results of the workshop will aim to validate the methodology and provide valuable material for descriptors related to portraits.
## 5.4 Summary

A summary of where the research has reached after the literature review is presented in Table 5.5.

<table>
<thead>
<tr>
<th>No.</th>
<th>Research questions</th>
<th>Literature review result</th>
<th>Next plan of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What is graphicacy?</td>
<td>Considerable information was gathered on this area. A definition of what graphicacy is has been formed.</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>Has graphicacy across the curriculum been studied before? If so, what are the findings?</td>
<td>Much existing information was reviewed.</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>How can we measure graphicacy?</td>
<td>Little information was found on the area</td>
<td>Develop a methodology and pilot test it. Validate its appropriateness through case studies.</td>
</tr>
<tr>
<td>4</td>
<td>Are there existing ‘graphicacy test’ or tests based on the skills of creating images?</td>
<td>Little information was found on the area</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>Where does graphicacy fit across the curriculum?</td>
<td>The information gathered did not provide a satisfactory answer.</td>
<td>Conduct research through analysis of textbooks across the curriculum</td>
</tr>
<tr>
<td>6</td>
<td>How does graphicacy appear in ‘teaching’ (within the sample of schools and subjects studied)?</td>
<td>Some information was gathered which did not provide a satisfactory answer.</td>
<td>Conduct research through analysis of textbooks across the curriculum.</td>
</tr>
<tr>
<td>7</td>
<td>What are the main similarities of the use of images across different subjects?</td>
<td>The information gathered did not provide a satisfactory answer.</td>
<td>Conduct research through textbooks’ analysis across the curriculum</td>
</tr>
<tr>
<td>8</td>
<td>Are there established methods for studying graphicacy within the curriculum?</td>
<td>The information gathered did not provide a satisfactory answer.</td>
<td>Develop a research tool as part of a new methodology to enable graphicacy to be studied within the curriculum.</td>
</tr>
<tr>
<td>9</td>
<td>Are there main stages/levels of drawing and/or mark making abilities that children go through?</td>
<td>Considerable existing information was reviewed.</td>
<td>Develop a methodology and run workshops and case studies collecting students’ work to be analysed.</td>
</tr>
<tr>
<td>10</td>
<td>How does graphicacy capability change/develop during the years of 10-15 years old?</td>
<td>The information gathered did not provide a satisfactory answer.</td>
<td>Develop the appropriate methodology and run workshops and case studies collecting students’ work to be analysed.</td>
</tr>
<tr>
<td></td>
<td>How fundamental is graphicacy to students' progress?</td>
<td>The information gathered did not provide a satisfactory answer.</td>
<td>Develop an analysis of cross-curricular links.</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>12</td>
<td>Is the potential offered by graphicacy fully exploited for the learning of all students?</td>
<td>The information gathered did not provide a satisfactory answer.</td>
<td>The review provided a clear answer: the potential offered by graphicacy has not been exploited fully for the learning of students.</td>
</tr>
<tr>
<td>13</td>
<td>Can co-research provide useful data for this research?</td>
<td>The information gathered did not provide a satisfactory answer.</td>
<td>Appropriate methodology to be developed, piloted and validated through another case study</td>
</tr>
</tbody>
</table>

Table 5.5 Research position after the completion of the literature review
5.5 The theoretical perspective of the study

Year 1 - grounded theory (Glaser & Strauss, 1967) will be the basic research method used in the first year. After the data collection, key skills and purposes of images from a learning perspective are grouped, they will be marked with a series of codes, such as colours. While looking for patterns, more categories are expected to surface forming patterns. These will be used to develop a new taxonomy for graphicacy and at a later stage, to identify the purposes images are used for across the curriculum.

Although the overall study is looking to see the effect graphicacy has on learning, the initial emphasis will lie on the use of graphicacy during teaching.

Years 2 and 3 - Taxonomic classification methods will be investigated, identified and used to classify level descriptors for the different types of images chosen for this research.
CHAPTER SIX

Research Methodology

Introduction of Chapter 1

The following chapter is divided into 3 main parts according to the focus of the research area. Section 6.1 describes in general the research approach. Section 6.2 is focused on the development of a research tool; a taxonomy of graphicy. The five stages of development of the tool are described following the method used to validate the outcome. Interviews as a research method is reported and the implementation of it is described. The first pilot study is described focusing on the methodology used for preparations and implementation. In a similar manner, case study 1 and case study 2 are described. All three studies used the research tool to analyse textbooks in order to identify graphicy use across the curriculum. Section 6.3 is focused on drawing descriptors for continuity and progression for certain graphacy elements. For all the studies completed, the planning and implementation of the methodology is described. There were 2 pilot studies and 3 case studies completed for this area. The following elements of graphicy were studied (in relation to continuity and progression descriptors): Perspective drawing, logo design, rendering, profile drawings and star profile charts. Section 6.4 is focused on the collaborations formed during the time of the entire study. Methodology preparation and implementation for co-research and a Delphi group technique are described.
6.1 Research approach

In this section the research methodology for carrying out the research strategy will be described, along with the pilot studies and the methods used for collecting and analysing data.

Within the research on the development of children's graphicity skills, no unanimity exists among researchers concerning the choice of research approach. Some researchers employ quantitative approaches (e.g. Furby and Beyth-Marom, 1992; Nisbet & Grimbeek, 2004), while some others adopt qualitative approaches (e.g. Mioduser & Kipperman, 2002). Cohen et al. (2007:3) assert that the choice of research approach must be guided by considering: “how can research questions best be answered?”

According to Robson (2002), in-depth information is necessary in order to reveal a complex issue like continuity and progression descriptors for elements of graphicity. Therefore, the purpose of this study is well suited to a qualitative research approach, as these can provide richer data for answering the research questions. As Cohen & Manion, (1994) argued, qualitative research enables the researcher to construct an insider’s perspective, which is important for obtaining a better insight of the participants’ perspectives. The benefit of qualitative methodology is that it allows for categories to be developed inductively from data and observations (Merriam, 2001). It was anticipated that a quantitative methodology would imply the use of predefined categories, and thus make the study less explorative (Bell, 1993). Potential methodologies that could be used include: lesson observations; interviews; focus groups; analysis of textbooks; analysing tasks; co-research and the use of a Delphi study group to help generalise and validate the findings (Danos & Norman, 2011b).

The studies described below follow a description given through a broad definition by Barab and Squire (2004) also supported by Roberts (2000);

‘a series of approaches, with the intent of producing new theories, artefacts, and practices that account for and potentially impact learning and teaching in naturalistic settings’.

The study’s methodological perspective is continually open to review. This is consistent with research and qualitative analytical techniques concerning the relationship between data and research issues, as well as a contributor to the continual revision of the assertions emanating from the study (Ritchie and Hampson, 1996). It involved direct observations of the pupils in action and employed a search for how children used new knowledge and how it enhanced their understanding (Patton, 1990). Therefore, data collection procedures will be aimed at capturing pupils’ specific understanding of different types of images, at different levels.

In implementing the research strategy, the research questions were grouped in three focus areas. These are: graphicity across the curriculum; graphicity continuity and progression descriptors; collaborations. This was necessary in order to make the data gathering as efficient as they could be.
This is illustrated in Table 6.1 where an introduction is given to the research strategy plan in relation to the 3 main areas of focus, broken down to the relevant research questions.

<table>
<thead>
<tr>
<th>Research focus area</th>
<th>Research questions</th>
<th>Methodologies</th>
<th>Pilot studies</th>
<th>Case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Graphacy across the curriculum</strong></td>
<td>What is graphicacy?</td>
<td>Literature review</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Has graphicacy across the curriculum been studied before? If so, what are the findings?</td>
<td>Literature review</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Where does graphicacy fit across the curriculum?</td>
<td>Literature review/Development of a taxonomy for analysis of textbooks</td>
<td>Pilot study 1: Analysis of textbooks in Cyprus</td>
<td>Case study 1: Analysis of textbooks in the USA</td>
</tr>
<tr>
<td></td>
<td>How does graphicacy appear in ‘teaching’ (within the sample of schools and subjects studied)?</td>
<td>Literature review</td>
<td>Case study 2: Analysis of textbooks in UK</td>
<td></td>
</tr>
<tr>
<td></td>
<td>What are the main similarities of the use of images across different subjects?</td>
<td>Literature review</td>
<td>Case study 2: Analysis of textbooks in UK</td>
<td></td>
</tr>
<tr>
<td><strong>Graphacy continuity and progression descriptors</strong></td>
<td>Are there existing ‘graphicacy test’ or tests based on the skills of creating images?</td>
<td>Literature review</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>How can we measure graphicacy?</td>
<td>Literature review/Development of tasks and assessment strategy for research within practice</td>
<td>Pilot study 2: Workshop on rendering, perspective and logo design</td>
<td>Case study 3: Star profile (research within practice)</td>
</tr>
<tr>
<td></td>
<td>Are there main stages/levels of drawing and/or mark making abilities that children go through?</td>
<td>Literature review/Development of tasks and assessment strategy for research within practice</td>
<td>Pilot study 3: Star profile</td>
<td>Case study 4: Portrait drawings (research within practice)</td>
</tr>
<tr>
<td></td>
<td>How does graphicacy capability change/develop during the years of 10-15 years old?</td>
<td>Literature review/Development of tasks and assessment strategy for research within practice</td>
<td>Pilot study 4: Workshop on portrait drawings, cartoon and caricatures</td>
<td>Case study 5: Co-research with PGCE students (2011)</td>
</tr>
<tr>
<td></td>
<td>How fundamental is graphicacy to students’ progress?</td>
<td>Literature review/Development of a taxonomy for analysis of textbooks</td>
<td>Pilot study 1: Analysis of textbooks in Cyprus</td>
<td>Case study 1: Analysis of textbooks in the USA</td>
</tr>
<tr>
<td></td>
<td>Is the potential offered by graphicacy fully exploited for the learning of all students?</td>
<td>Literature review/Development of a taxonomy for analysis of textbooks</td>
<td>Case study 2: Analysis of textbooks in UK</td>
<td></td>
</tr>
<tr>
<td><strong>Collaborations</strong></td>
<td>Can co-research provide useful data for this research?</td>
<td>Literature review/Development of suitable approach and</td>
<td>Pilot study 5: Co-research with PGCE students (2010)</td>
<td>Case study 4: Portrait drawings (research within practice)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Literature review/Development of suitable approach and</td>
<td>Case study 5:</td>
<td></td>
</tr>
</tbody>
</table>
6.1.1 Methods of Data Collection

For the purpose of this study, two main methods were used for data collection. The primary methods will be analysis of textbooks which will be re-enforced by the data collected during semi-structured discussions with the teachers and workshops within practice. Once the data are all collected and analysed, the results will then be discussed with professionals and academics in the field.

6.2 Developing a research tool

A taxonomy of graphicacy had to be developed as a research tool in order for the research across the curriculum to be undertaken, in order to identify graphicacy use.

The taxonomy was developed through five stages:
- Stage 1: Developing categories from the literature review
- Stage 2: Identifying learning skills and purposes of images
- Stage 3: Visually representing the emerging concept of graphicacy
- Stage 4: Articulating the meaning of the main categories
- Stage 5: Defining the new taxonomy of graphicacy

6.2.1. Stage 1- Developing categories from the literature review

A table was created by bringing together information from the literature review (Chapter 2, Tables 2.3 to 2.10) forming the types of images incorporated in the taxonomy for graphicacy. The types of images were grouped according to the skills required when using these as a communication tool. In this initial stage, 8 main categories emerged, with a number of subcategories. These are shown in Table 6.2.
Table 6.2 Developing categories from the literature review

<table>
<thead>
<tr>
<th>Artistic (graphic arts) – pictorial</th>
<th>Diagram – pictorial</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Art</td>
<td>I. Annotated</td>
</tr>
<tr>
<td>II. Life drawing</td>
<td>II. Engineering/ technical</td>
</tr>
<tr>
<td>III. Landscape drawing</td>
<td>III. Architectural</td>
</tr>
<tr>
<td>IV. Portraits</td>
<td>IV. Projections (orthographic, isometric, oblique)</td>
</tr>
<tr>
<td>V. Life drawing</td>
<td>V. Perspective</td>
</tr>
<tr>
<td></td>
<td>VI. Exploded</td>
</tr>
</tbody>
</table>

3 Drawing – pictorial

<table>
<thead>
<tr>
<th>Sequential – linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Drafts</td>
</tr>
<tr>
<td>II. Sketching</td>
</tr>
<tr>
<td>III. Drawing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAD – spatial</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. 3D virtual environment</td>
</tr>
<tr>
<td>II. 3D virtual products</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbolic – omitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Symbols</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbolic – spatial (mathematical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Charts</td>
</tr>
<tr>
<td>II. Graphs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbolic – spatial (mathematical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Maps/ cartograms</td>
</tr>
<tr>
<td>II. Photographs</td>
</tr>
<tr>
<td>III. Posters/ advertisements</td>
</tr>
</tbody>
</table>

6.2.2 Stage 2: Identifying learning skills and purposes of images

From the Table 6.2 and further literature, the most common learning skills and purposes were drawn together and illustrated using colour coding (Figure 6.1). The same colour was used when repeating the same learning skill or purpose, under the different graphicacy element. This was a means to identify links or patterns between the purposes of images and skills required to deal with various images from a teaching and learning perspective. For example, spatial conception is enhanced through orthographic diagrams, map reading, CAD, life drawing, architectural/ engineering drawing and landscape and portrait drawings. A list of prospective purposes, skills and learning outcomes concerning graphicacy was starting to form, which helped with the initial stages of placing graphicacy into context and gaining deeper understanding.
Figure 6.1 Skills and purposes of images from a learning perspective
6.2.3 Stage 3: Visually representing the emerging concept of graphicacy

The following diagram (Figure 6.2) was produced as part of the preparation of the pilot study on identifying graphicacy across the curriculum. The main concept of graphicacy is illustrated. Starting from the 4 basic communication skills, literacy, numeracy, articulacy and graphicacy, it continues by breaking down graphicacy into the main 7 categories. A key word was chosen to represent the learning purpose of each category. These were taken from Figure 6.1, where the most common word under each category emerged. The main purposes and skills for communicating through graphicacy were listed and placed opposite a list of tests identified through the literature review, conducted to measure some aspects of graphicacy. A list of all the potential subject areas to be encountered in the pilot study was also drawn up to aid the preparation of the study.

![Figure 6.2 The concept of graphicacy illustrated](image-url)
6.2.4 Stage 4: Articulating the meaning of the main categories

Having defined the categories, the meaning of each of the categories was articulated to ensure a clear definition and differentiation between each category. The most appropriate description from a number of online encyclopaedias in comparison with the information gathered from the literature review was chosen. A sample illustrating how the definitions were brought together is shown in Table 6.3. A full list of the descriptions is provided in Appendix 4.1.

At this stage, brainstorming and flow diagrams were added into the sequential category. These two types of images were drawn from personal experience as they were commonly used by fellow teachers in various subject areas as well as during lessons while working as a design and technology teacher. These two types of images did not emerge from the literature.

Taking into account the great similarities within the descriptions given on graphs and charts from the various encyclopaedia sites and through the literature, it was thought appropriate to merge the two categories into one.

<table>
<thead>
<tr>
<th>Drawing/ pictorial</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. <strong>Draft</strong>: A draft is a copy of a material made for examination and correction before the final production (<a href="http://www.ask.com/web?q=dictionary%3A+draft&amp;content=ahdict%7C43491&amp;o=0&amp;i=dir">http://www.ask.com/web?q=dictionary%3A+draft&amp;content=ahdict%7C43491&amp;o=0&amp;i=dir</a>)</td>
</tr>
<tr>
<td>II. <strong>Sketching</strong>: A hasty or non-detailed drawing or painting which is a brief general account or presentation often made as a preliminary study (<a href="http://www.ask.com/web?q=dictionary%3A+sketching&amp;content=ahdict%7C13864&amp;o=0&amp;i=dir">http://www.ask.com/web?q=dictionary%3A+sketching&amp;content=ahdict%7C13864&amp;o=0&amp;i=dir</a>)</td>
</tr>
<tr>
<td>III. <strong>Drawing</strong>: A picture or plan made by means of lines on a surface representing objects or forms (<a href="http://www.thefreedictionary.com/drawing">http://www.thefreedictionary.com/drawing</a>)</td>
</tr>
</tbody>
</table>

Table 6.3 A sample of the way the meaning of the categories’ was articulated

6.2.5 Stage 5: Defining the new taxonomy of graphicacy

At an early stage the initial taxonomy required some level of completion as it was to be used as a research tool for the upcoming pilot study. The categories were put together and appropriate examples were gathered from the internet to illustrate each one. This initial taxonomy was focused on clearly illustrating the categories of images for graphicacy. It was formed in a way as to help teachers from different subjects identify where graphicacy was used during their teaching as well as in other subject areas. For this reason, the images
chosen as examples represented visual images that could be used across a wide range of subject areas.

The complete taxonomy as used for the studies with the 3 schools (1 pilot study and 2 case studies) is illustrated below (Table 6.4). The first page in this figure provides additional information; the explanation of each category in Greek. This has been created to provide the reader with an example of the resources used during the pilot study. During the studies, the explanations were provided only in one language. A cover page was also included during each study with this author’s name, University and department, title of research area, date and the name of the school participating in the study. This, along with the explanations of each subcategory were modified and translated according to the country.

**ΚΑΛΛΙΤΕΧΝΙΚΕΣ/ΕΙΚΟΝΟΓΡΑΦΙΚΕΣ/ΓΡΑΦΙΚΕΣ ΤΕΧΝΕΣ**

**ΤΕΧΝΗ ART**

Η τέχνη είναι η διαδικασία ή το προϊόν μιας σκέψης και δημιουργικούς ενέργειας και τεχνοτροπίεςς στοιχείων με τρόπο ώστε να απεικονίσουν στην αισθήσεις ή τα συναισθήματα.

Art is the process or product of deliberately and creatively arranging elements in a way that appeals to the senses or emotions. In its narrow sense. (http://en.wikipedia.org/wiki/Art)

**ΣΧΕΔΙΟ ΦΙΓΟΥΡΑΣ LIFE DRAWING**

Το σχέδιο ζωής συναρτά στη διαδικασία παρατήρησης και ζωγραφικής ζωντανών ζωτικότητας από την παρατήρηση ενός έμβους ή ας πρότυπο.

Life drawing refers to the process of drawing living beings figures from observation of a live model. (http://en.wikipedia.org/wiki/figure_drawing)

**ΣΧΕΔΙΟ ΤΟΠΙΩΝ LANDSCAPE**

Το σχέδιο τοπίων παραλαμβάνει τα φυσικά χαρακτηριστικά γνωρίσματα μιας περιοχής του εδάφους, συμπεριλαμβανομένων των φυσικών στοιχείων όπως τους σχηματισμούς εδάφους, των στοιχείων διαβίωσης της χλωρίδας και της περιβάλλοντος, των ανθρωπισμένων στοιχείων όπως ο φυτισμός και οι κατακόρυφες συνήθειες και των ανθρώπινων στοιχείων, για παράδειγμα της ανθρώπινης δραστηριότητας ή του χρηματικού περιβάλλοντος.

Landscape drawing comprises the visible features of an area of land, including physical elements such as landforms, living elements of flora and fauna, abstract elements such as lighting and weather conditions, and human elements, for instance human activity or the built environment. http://www.babylon.com/definition/landscape/ English
**ΠΟΡΤΡΕΤΟ PORTRAITS**

Το πορτρέτο είναι μια ζωγραφική, φωτογραφία, γλυπτό ή άλλη καλλιτεχνική αντιπροσωπεύσεις ενός προσώπου, στις οποίες κοινώς ονομάζουμε το πρόσωπο και η έκφραση του. Η πρόταση προκειμένου να επεξεργαστεί την έμπνευση, την προσωπικότητα, και ακόμη και τη διάθεση του προσώπου.

A portrait is a painting, photograph, sculpture or other artistic representation of a person, in which the face and its expression is predominant. The intent is to display the likeness, personality, and even the mood of the person. [http://en.wikipedia.org/wiki/Portrait](http://en.wikipedia.org/wiki/Portrait)

**ΝΕΚΡΗ ΦΥΣΗ STILL LIFE**

Μια αντίθετη ζωή είναι, ένα δρίστο της τέχνης όπου επικεντρώνεται συνήθως ένα άγερο περιεχόμενο, χαρακτηριστικά κοινά συμπεριλαμβάνοντας μπροστινά (πρόσωπα, λουλούδια, εγγεγραμμένες, βραχιόνες, ή κοχύλια) πέτρες παραστημένοι από αποκαλούμενο (γυαλί, κακτούλωσης, βιβλία, βάζα, κορμόκτητα, ναομίζοντα, σωλήνες, και άλλα κατεξής) σε μια τεχνητή ρύθμιση.

A still life (plural still lifes is a work of art depicting mostly inanimate subject matter, typically commonplace objects which may be either natural (food, flowers, plants, rocks, or shells) or man-made (drinking glasses, books, vases, jewellery, coins, pipes, and so on) in an artificial setting. [http://www.answers.com/topic/still-life](http://www.answers.com/topic/still-life)

**DRAWING / PICTORIAL**

**DRAFTS**

A draft is a copy of a material made for examination and correction before the final production. [http://www.ask.com/web?q=dictionary%3A+draft&content=ahdict%7C43491&o=0&l=dir](http://www.ask.com/web?q=dictionary%3A+draft&content=ahdict%7C43491&o=0&l=dir)

**SKETCHING**

A hasty or non-detailed drawing or painting which is a brief general account or presentation often made as a preliminary study. [http://www.ask.com/web?q=dictionary%3A+sketching&content=ahdict%7C138644&o=0&l=dir](http://www.ask.com/web?q=dictionary%3A+sketching&content=ahdict%7C138644&o=0&l=dir)

**DRAWING**

A picture or plan made by means of lines on a surface representing objects or forms. [http://www.thefreedictionary.com/drawing](http://www.thefreedictionary.com/drawing)
**DIAGRAMS / PICTORIAL**

**ANNOTATED**

A figure or drawing made to illustrate a statement or facilitate a demonstration (a diagram) with a series of explanatory notes. [http://www.biology-online.org/dictionary/Annotated_Diagram](http://www.biology-online.org/dictionary/Annotated_Diagram)

**ENGINEERING / TECHNICAL**

A graphical language used by engineers and other technical personnel associated with the engineering profession. The purpose of engineering drawing is to convey graphically the ideas and information necessary for the construction or analysis of machines, structures, or systems. [http://www.answers.com/topic/engineering-drawing](http://www.answers.com/topic/engineering-drawing)

**ARCHITECTURAL**

Rendering or drawing of an architectural design as plan and/or elevation views of a building or structure. [http://www.businessdictionary.com/definition/architectural-drawing.html](http://www.businessdictionary.com/definition/architectural-drawing.html)

**PROJECTIONS (ORTHOGRAPHIC, OBLIQUE, ISOMETRIC)**


**PERSPECTIVE**

Perspective in the graphic arts, such as drawing, is an approximate representation, on a flat surface (such as paper), of an image as it is perceived by the eye. [http://en.wikipedia.org/wiki/Perspective_(graphical)](http://en.wikipedia.org/wiki/Perspective_(graphical))

**EXPLODED**

An exploded view is a representative picture or diagram that shows the components of an object slightly separated by distance, or suspended in surrounding space in the case of a three-dimensional exploded diagram. [http://en.wikipedia.org/wiki/Exploded_view](http://en.wikipedia.org/wiki/Exploded_view)
**CAD (Computer Aided Design) / SPATIAL**

**COMPUTER AIDED IMAGES**

Use of computer programs and systems to design detailed two- or three-dimensional models/images. [http://www.thefreedictionary.com/computer-aided+design](http://www.thefreedictionary.com/computer-aided+design)

**3D VIRTUAL IMAGES/ Computer Aided Design**

Computer-aided design (CAD) is the use of computer technology to aid in the design and particularly the drafting (technical drawing and engineering drawing) of a part or product, including entire buildings. It is both a visual (or drawing) and symbol-based method of communication whose conventions are particular to a specific technical field. [http://en.wikipedia.org/wiki/Computer-aided_design](http://en.wikipedia.org/wiki/Computer-aided_design)

**SEQUENTIAL / LINEAR**

**CARTOONS**

An often humorous or satirical drawing to evoke emotions, usually with a caption. A cartoon is typically a simple-lined drawing and tells a story or continues a story; it can consist of one or more pictures or frames. [www.worldimages.com/art_glossary.php](http://www.worldimages.com/art_glossary.php)

**STORY BOARDS**

Originally, a series of drawings that lay out the sequence of scenes in a film, especially an animated one, but now any sequence of drawings. [en.wiktionary.org/wiki/storyboard](http://en.wiktionary.org/wiki/storyboard)

**SPIDER DIAGRAM / BRAINSTORMING**

Brainstorming is a group creativity technique designed to generate a large number of ideas for the solution to a problem. [en.wikipedia.org/wiki/BRAINSTORMING](http://en.wikipedia.org/wiki/BRAINSTORMING)

**FLOW DIAGRAM**

Graphic means of presenting an overview of how processes work, usually consisting of graphic boxes and other shapes, and lines and arrows. [www.techcommunicators.com/diagram/glossary.html](http://www.techcommunicators.com/diagram/glossary.html)
6.2.6 Validating and applying the taxonomy

Before it was used as the primary research tool for the analysis of textbooks, the taxonomy was validated through interviews with design and technology experts. It was piloted in a school in Cyprus with subsequent research in schools in the USA and UK (Table 6.4).
6.2.7 Interviewing as a research methodology

Once the taxonomy was completed, it was examined by 3 design and technology education lecturers to seek their views concerning its suitability. ‘Interviews enable participants – be they interviewers or interviewees – to discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view’ (Cohen et al 2004: 267). In addition, ‘as an interview, an interchange of views between two or more people on a topic of mutual interest, sees the centrality of human interaction for knowledge production and emphasises the social situatedness of research data’ (Kvale, 1996:1).

‘The research interview has been defined as a two person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information, and focused by him on content specified by research objectives of systematic description, prediction, or explanation’ (Cannell & Kahn, 1968:527). The importance of this issue was brought by Laing (1967:66) who stated that ‘it is not exclusively either subjective or objective, it is inter-subjective’.

6.2.8 Implementing interview methodology for validating the taxonomy

The first interview was conducted with one academic and the second interview was conducted with two academics. The interviews were semi-structured. The questions were mostly open-ended questions as the information searched for was qualitative. The key questions and stages followed were:

Stages:

1. Description of the overall research, the motivation behind this and the final goal of the research.

<table>
<thead>
<tr>
<th>Research study</th>
<th>Pilot study</th>
<th>Case study</th>
<th>Case study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Cyprus</td>
<td>USA</td>
<td>UK</td>
</tr>
<tr>
<td>Age range</td>
<td>11 -14 years</td>
<td>16 – 18 years</td>
<td>11 -14 years</td>
</tr>
<tr>
<td>Status</td>
<td>Government funded</td>
<td>Tuitons ($20,000 - $33,000 per year)</td>
<td>Government funded</td>
</tr>
<tr>
<td>Funding for textbooks</td>
<td>Government funded</td>
<td>School funded</td>
<td>Department school funded</td>
</tr>
<tr>
<td>Selection of textbooks</td>
<td>Government</td>
<td>Teacher</td>
<td>Department</td>
</tr>
<tr>
<td>Teacher qualifications</td>
<td>Teaching degree</td>
<td>Masters/ Ph.D</td>
<td>Teaching degree</td>
</tr>
<tr>
<td>Status</td>
<td>Indifferent</td>
<td>Highly academic</td>
<td>Motivational</td>
</tr>
<tr>
<td>Teachers &amp; research</td>
<td>Unfamiliar and wary</td>
<td>Friendly and familiar</td>
<td>Willing but unfamiliar</td>
</tr>
</tbody>
</table>

Table 6.4 A summary of the key criteria for each school used in this study
2. Description of how the taxonomy was brought together and how the categories were formed.
3. Discussion on the suitability of the categories.
4. Validation of its suitability

Questions:
1. From your experience, would you say the taxonomy covers the full range of graphicy?
2. Do you consider the categories appropriate?
3. Do you expect this to work as a research tool to identify where graphicacy is used across the curriculum?
4. Do you find the images used as examples satisfactory in illustrating the concept of each type across a range of different subject areas?

All three academics challenged the categories until satisfied with the reasoning behind each one. This had provided the research tool required to proceed with the first area of the main research. The pilot study conducted to test the methodology and gather initial results is described in the next section.

6.2.9 The pilot study

Silverman (2000) suggests that the reliability of the data collection tools can be enhanced by carefully piloting them. The pilot study was conducted in a school in Cyprus and was divided into 2 activities; informal discussion with teachers, and analysis of textbooks. The main purpose of the informal discussions during the pilot study was to gather information and gain understanding with regards to the use of graphicacy across the curriculum, and the teacher’s opinion and attitude towards its importance, having direct bearing on the research objectives. Tuckman (1972) describes this as ‘providing access to what is ‘inside a person’s head’, [it] makes it possible to measure what a person knows (knowledge or information), what a person likes or dislikes (values and preferences), and what a person thinks (attitudes and beliefs’).

The secondary purpose was to test the appropriateness of the new taxonomy for graphicacy by enabling new theoretical positions to be developed through the analysis of the data gathered. The study was focused mainly on the teaching aspect of graphicacy instead of the demonstrating of learning through graphicacy. Only a few examples of students’ work were available to be collected and/or photographed during the pilot study.
6.2.10 Cyprus school description (School A)

The Cypriot school used for the pilot study is a typical Cypriot lower, secondary, mixed, state school (KS3). Students are aged 11-14 years old. All subjects are compulsory for these age ranges. The school is in an area considered to be middle-to low-class, and the students and most teachers live locally to the school. Teachers in Cyprus are relocated every 3 to 5 years. Despite this a few teachers have been in this same school for the past eight to ten years. In Cyprus, the textbooks are provided free from the government. It is therefore safe to assume that the types of images gathered from the interview and analysis of textbooks form a true representation of the potential for graphicacy use in the majority of secondary schools in Cyprus. In most subject areas, there are 31 to 33 students per class.

6.2.11 Pilot study discussion methodology

Features of the discussions: The following attributes adopted from the methodology for conducting interviews were aimed to be used for all discussions:

- Trust, by creating a comfortable environment. It was clearly explained to the respondents that there was no wrong/bad or right/good answer. The interview expressed curiosity, a desire to know and understand the respondents’ views, perceptions and hear about their stories and feelings.
- The questions were kept simple and to the point avoiding too much depth which could potentially make the respondent feel uneasy.
- It was taken into consideration that the respondents were going to hold back part of what was in their power to state for various reasons.
- To avoid miscommunication, follow up questions were used to validate understanding of the respondent’s information.

6.2.12 Format of discussion

The discussions were conducted as less formal, semi-structured interviews. As Lincoln and Guba (1985:269) explain “the unstructured interview is useful when the researcher is not aware of what she does not know, and therefore, relies on the respondents to tell her!’

The primary aims during the discussion were to portray and capture the uniqueness of the particular situations in response to graphicacy within each subject area. This format also allowed freedom to modify the sequence and wording of the questions as well as the speed of the interview. Taking under consideration the different cultural and educational background of the respondents, this method provided a clear understanding for the respondent. As Oppenheim (1992:86) indicates ‘standardisation should refer to stimulus equivalence, i.e. that every respondent should understand the question in the same way, rather than replicating
the exact wording, as some respondents might have difficulty with, or interpret very differently, and perhaps irrelevantly, particular questions’.

One advantage of this format is that it allows for greater depth when it comes to the methods of data collection. A disadvantage is that it is prone to subjectivity and bias on the part of the interviewer. The measurement of responses, comparability of one set of responses with another and the correlation of responses came as a natural progression during the analysis of the results in an attempt to find regularities. This helped in making generalisations concerning the purpose of use of the drawings.

Most of the questions used were open-ended questions which have a number of advantages: ‘they allow the participants to probe so that they may go into more depth if they choose, or to clear up any misunderstandings; they enable the interviewer to test the limits of the respondent’s knowledge; they encourage co-operation and help establish rapport; and they allow the interviewer to make a truer assessment of what the respondent really believes. Open-ended questions can also result in unexpected or unanticipated answers which may suggest hitherto unthought-of relationships or hypotheses’ (Cohen et al 2004: 275).

6.2.13 Approach of discussion

The planning and preparation occurred before the meetings, covering the specific topics and issues to be discussed. This helped in collecting systematic data for each respondent. In addition, the outline increased the comprehensiveness of the data. Planning in advance allowed for logical gaps in data to be anticipated which were covered by follow-up questions. Overall, the meetings remain conversational and on the subject. However, taking into consideration the weaknesses of this method, it was accepted that central and significant topics may be unintentionally omitted. For this reason, the discussion lasted as long as it was needed to ensure a cross validation of information.

Tuckman’s (1972) advice was taken under consideration in regards to setting up and conducting the discussion. This meant that at the meeting the interviewer briefed the respondent as to the nature and purpose of the meeting and attempted to make the respondent feel at ease. This seemed successful in all meetings. The manner in which the recording of the discussions would take place was explained, and permission was asked for tape recording the meeting.

At all times this researcher kept in mind that this was a data collection study and tried not to let biases, opinion or curiosity affect the researchers’ behaviour. This researcher attempted not to deviate far from the format and meeting schedule although some flexibility was permitted. The respondents were kept from rambling away from the essence of a question, but not at the sacrifice of courtesy.
6.2.14 Key questions
As Kerlinger (1970) notes ‘although the research purposes govern the questions asked their content, sequence and wording are entirely in the hands of the interviewer. This does not mean, however, that the unstructured interview is a more casual affair, for in its own way it also has to be carefully planned’. The key questions asked during the semi structured discussions are show in Table 6.5.

<table>
<thead>
<tr>
<th>Question</th>
<th>Type of question</th>
<th>Area of interest</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you use these types of images?</td>
<td>Closed</td>
<td>Gather information to help identify which images are used in each subject.</td>
<td>These results were based on the personal preference of the teacher and the textbooks used in class.</td>
</tr>
<tr>
<td>At what levels?</td>
<td>Open</td>
<td>This was a question intended to identify which types of images are used in different levels.</td>
<td></td>
</tr>
<tr>
<td>How do you use them? At what levels?</td>
<td>Open</td>
<td>Allow the teacher to talk on the way images were used in the lesson and their expectations of the students' understanding of them.</td>
<td>This was a key question in getting qualitative information.</td>
</tr>
<tr>
<td>Are there any issues with the teaching/learning using such images? Can you elaborate?</td>
<td>Open</td>
<td>This question was designed to be general and non-specific with the aim of 'leading circuitously to the desired information but with less alarm by the respondents' (Tuckman, 1972).</td>
<td>Tuckman also suggests that by making the purpose of the question less obvious the indirect approach is more likely to produce frank and open responses.</td>
</tr>
<tr>
<td>Can you give me an example of where/ how it is used?</td>
<td>Open</td>
<td>This question had multiple purposes. One was for the teacher to demonstrate understanding on what had been explained to them in the introduction; of what graphicacy is and what the overall purpose of this study was. The second purpose was for the teacher to pinpoint some of the most commonly used Images within the textbooks.</td>
<td>As with Kerlinger’s (1970) definition of 'open-ended items these are questions 'that supply a frame of reference for respondents' answers, but put a minimum of restraint on the answers and their expression'.</td>
</tr>
</tbody>
</table>

Table 6.5 Key questions for semi-structured discussions
6.2.15 Communicating the aim of the study

For the purpose of this study, the rationale of the investigation (thematising) and a brief description of the meetings were written in a letter form (Appendix 4.2). The letter was given to all participants in advance of the meetings, in Cyprus, the USA and UK. The letter was entitled ‘Aim of the survey’ and included:

- the level of academic degree this research was conducted for;
- the researcher’s name;
- the university’s name, department;
- country.

The letter introduced the area of graphicacy and its importance in everyday life as well as the significance of it in education, and across the curriculum. Examples of image use in specific subject areas were provided. Three main points were given as the main aims of this survey:

1. to investigate how visual communication (graphicaly) is used across the curriculum within a Cypriot, American and English secondary school;
2. how teachers use it in the classroom;
3. how teachers expect their students to deal with this visual information.

An invitation for 30 minute long individual meetings with teachers from various disciplines was given for pilot study 1 and case study 1. The relevant dates for this study were provided and further contact details were offered to arrange meetings.

6.2.16 Preparation for the analysis of textbooks

Teachers from various disciplines agreed to provide the textbooks used for different year groups. A camera was used to capture evidence of graphicacy use within the textbooks. This media was selected due to the speed and efficiency it provides in gathering large amounts of data in a short time span. The other alternatives were to either take copies of the books to be analysed privately while thorough records would be kept or scan-in each page containing a relevant image. It was of importance to also keep a record of any text based information connected with each image, to indicate the context the image was used in. Each book analysed was recorded by photographing the cover page which included the name of the book, authors, subject area it related to and the year group is was intended for. Three cameras were used in each study, each with an extra battery pack. A laptop was also used to empty the memory cards once full.

6.2.17 Permissions granted for the studies

The Principals from all 3 schools involved in this research (during the pilot study and case studies) were research friendly. They agreed for the study to be conducted in their school
during the following dates: 7th – 9th January’09 in Cyprus, 6th, 9th and 10th of February’09 in USA and 4th and 5th of February’10 in the UK. The conditions given by the Principals were not to interview or take photographs of any students, and use the school anonymously within the research report.

6.2.18 Pilot study 1 preparation and implementation

Permission to conduct the study was required from the Principal of the school. A champion was used to help bring the plans for the study to fruition. In Cyprus this was Mrs Stephanou, a personal friend and a teacher. Mrs Stephanou is a very active member of the school. She has been working in this school as a food technology teacher for approximately 8 years. A number of stages were conducted for the preparation and implementation of this study:

1. Inform the champion of the research of the aim of the study to be undertaken in the school (Appendix 4.3).
2. Engage the champion in an active conversation and discussion on graphicacy and the taxonomy.
3. Get the approval of the Principal of the school, to conduct the study during a set time frame. Agree on terms and conditions.
4. Translate the key documents to be used in the study to Greek. These included the letter stating the aim of the study, the taxonomy of graphicacy and the consent form.
5. Inform the staff of the school of the aim of the study and organise/arrange meetings. These were arranged once the researcher was in the school.
6. Designate an area for the researcher within the school to be used as a base for data gathering from textbooks etc.
7. Undertake meetings with teachers and collect relevant textbooks. Ensure moral and ethical issues are followed.
8. Visit classrooms to discuss teaching aids and students’ work mounted on the classrooms’ walls.
9. Take photographic evidence as data gathering from each textbook provided for the different subject areas.

A detailed report on the implementation of the above methodology in the Cypriot school is provided in Appendix 4.3. In total, 1026 photographs were taken (Annex 1). Often a photograph included evidence of a number of different types of images in use.

6.2.19 Case study 1

The first case study on identifying graphicacy across the curriculum was completed in the USA. A similar methodology was used to that followed in the pilot study. This was due to the
success the methodology proved to have. Mr Janes served as a champion and helped with bringing the plans for this study in fruition. Mr Janes is a teacher and a PhD researcher based in Boston, USA.

6.2.20 USA school description (School B)

The school in the USA (referred to as school B in this document) was very different to the one in Cyprus. This school was a private, mixed school with very high annual fees (ranging from $20,000 - $33,000). Students from this school are expected to go on to higher education, with a high percentage of students entering Harvard, Oxford, Cambridge, or other universities of a similarly prestigious status. Teachers in this school usually do not leave unless they retire. For this reason, most teachers have been in this school for more than 5 years. The school is divided into lower, middle, and upper schools, with 330, 175, and 480 students, respectively. In total, there are 985 students. The teacher-student ratio is 8:1. The survey was conducted in the upper school, which deals with year groups 9 to 12 (ages 14-18 years old).

6.2.21 Case study 1 preparation and implementation

Case study 1 was conducted following a very similar method as in the pilot study 1. Stages 1-3 were followed in exactly the same manner. Stage 4 was not required as the documents were already in the main spoken language (English). Stage 5 had one additional element. A poster was created by this researcher (Figure 6.4) which was printed out and posted in the various staffrooms of the school by Mr Janes. The poster was used as a catalyst to draw attention to the upcoming study and encourage teachers to participate. Meetings with teachers were organised prior to the study through email communication. Stages 6 to 9 relating to the implementation of the study were the same as in the pilot study. Appendix 4.4 offers a detailed report of the above stages. A total of 400 photographs were taken (Annex 2). As was often the case, one photograph provided evidence of a number of different images in use.
6.2.22 Case study 2
The second case study completed was in the UK. Once again, a similar methodology was used as in the pilot study. Mr Macfrici, the head of design and technology department of the school, served as a champion to help bring this study to fruition.

6.2.23 UK school description (School C)
School C is a government funded, lower school with students ranging between 11-14 years old. Teachers are actively involved in constantly upgrading their schemes of work, which has resulted in the school being awarded an “outstanding” achievement for their curriculum from
the recent (British) Office for Standards in Education (OFSTED) report. In most subject areas there are approximately 30 students per class. The textbooks used in each subject are agreed on by each individual department. Some departments allow individual teachers to choose textbooks of their preference. The results from this study do not provide an accurate national account of image use across the subjects studied. They do provide an example of potential image use.

6.2.24 Case study 2 preparation and implementation

The same methodology was used as in case study 2. Stages 1 to 3 relating to informing the champion of the research aims and objectives and getting the Principal’s approval were followed as before (a report of these can be found in Appendix 4.5). Once again the documents did not have to be translated as they were already in English (pilot study stage 4). Stage 5 of the pilot study was missed out during case study 2 as no other members of the staff were involved. No meetings or discussions were held with any teachers from the school other than Mr Macfrici. This was part of the agreement with the Head of the Department as there was additional agreement for further work relating to research on continuity and progression (CaP) descriptors. This would require some of the teachers’ time to be arranged and it was decided not to use much of their time for this case study. Books were collected from a number of different subject areas and photographic data were collected.

This case study was focused on the analysis of textbooks without verbal feedback from the teachers. Textbooks were provided from the following subject areas: design and technology, English language, French, geography, mathematics and religious studies. The areas under science; biology, chemistry and physics provided digital textbooks in the form of DVDs. The relevant pages of the textbooks were photographed as described in case study 1. Three hundred and thirty nine photographs were taken and analysed (Annex 3). Copies of the science digital textbooks were provided by the teachers for analysis. No photographic evidence were taken of these, as it was considered an unnecessarily time consuming task. The analysis was done by working through the information provided on the DVDs.

6.2.25 Ethical issues

The discussions conducted in the schools were treated as informal discussions/ interviews. ‘Interviews have an ethical dimension; they concern interpersonal interaction and produce information about the human condition’ (Cohen et al, 2004:292).

This research project has been approved by Loughborough University’s Ethical Advisory Committee. During the pilot study 1 and case study 1, the informed consent of the interviewees was obtained in writing (Figure 6.3.1. provided in Appendix 4.3), given to the
teachers approximately two weeks before the meetings. During the discussions, the importance of identifying graphicacy as a core communication skill was explained to participants and they were informed of the possible outcomes of the research including the possibility of measuring levels of graphicacy in the future. It was explained to participants that all information exchanged during the discussion would be used confidentially and anonymously unless they chose to be acknowledged. If used anonymously, the information would be non-traceable and non-identifiable. The only people that will have access to the personal information of the participants would be the researcher. The data will be destroyed soon after the completion of the PhD degree. To ensure that the discussion is conducted in an appropriate, non-stressful and non-threatening manner, the participants chose the room for the session which was within their school area. A well prepared semi-structured discussion (in the form of an interview) was also a key factor on this matter.

6.2.26 Methodology of data analysis: Graphicacy across the curriculum

The main tool used in order to generate natural units of meaning was the taxonomy of graphicacy. The categories and subcategories of the taxonomy were used as the initial units of meaning.

The process of analysing and interpreting the data formed a number of stages. The first 4 stages were used to interpret the data to answer the question ‘where does graphicacy fit across the curriculum?’ Stages 5 - 7 were used to identify patterns within the results. Stages 8 - 9 began revealing relations between variables. These stages are described below:

Stage 1 – Photographs taken during the interview were cropped and the lighting balance was corrected using Photoshop.
Stage 2 – Individual images were tagged (on the computer) using the relevant categories from the taxonomy.
Stage 3 - All files (images) were grouped in relevant folders (on the computer) according to their type.
Stage 4 - The number of types of images used across each of the subjects in the curriculum were counted and mapped. The number of subject areas using each type of image was also counted. An example of this method is illustrated in Figure 6.5.
Stage 5 – Images per subject area, were placed in the taxonomy (Figure 6.6)
Stage 6 – Images were clustered into subject areas. All images taken from each subject area were placed together and tagged according to the type of image. Examples of these are shown in Figure 6.7.
Stage 7 – Images were clustered into the type of image. All images of the same type that had been gathered were placed together and tagged according to the subject area they came from. Examples of these are shown in Figure 6.8.

Figure 6.7 A sample of categorising results: Types of images used per subject area

Figure 6.8 A group of images of the same types of image from all the subjects who use it.

Stages 5 – 7 were used for making metaphors. Figurative and connotative language was used such as graphs, which brought data to life, made patterns and connected data with theory of how graphicacy was used across the curriculum. A move towards clarifying key concepts was completed in an attempt to identify patterns and relationships between subjects and/or the type of images used.

Stage 8 - Patterns and themes which stem from repeated themes were noted. These are discussed further in Chapter 7.
Stage 9 - Relations between variables were identified and noted. These are also discussed further in Chapter 7.
6.3 Descriptors for continuity and progression

6.3.1 Introduction
Progression and development in graphicacy are being explored in relation to the previously reported taxonomy. A research strategy was developed to test a number of methodologies to enable progression level descriptors to be formed, in regards to 3 types of images within 3 different areas of the taxonomy; rendering (graphic arts: still life), symbolic representations (symbolic: abstract) and perspective drawing (pictorial: diagrams). Tasks for each area were designed for a pilot study and tested with 24 Year 10 students during a workshop conducted at Loughborough University. The analysis of the results tested different methods of analysis and provided new information for more detailed and exact descriptors of continuity and progression (CaP). These were used in a collaborative research project conducted by this researcher and the PGCE students at Sheffield Hallam University. The concept and a method for co-research were tested and some results are described. Analysis of the methodology is reported. The limitations and potentials of co-research are discussed in the Chapter 8.

6.3.2 Strategy
Three areas of the taxonomy were chosen and associated tasks were identified during the initial exploration of the issues involved in identifying CaP (continuity and progression) descriptors of graphicacy skills. These tasks were developed into a research methodology which was tested in a pilot study conducted with a Year 10 group of students in association with their visit to the ‘Quick on the Draw exhibition’ (Baynes, 2008) at Loughborough University.

The research conducted on how tasks could be developed and analysed in order to explore CaP descriptors in graphicacy skills for Years 7, 8 and 9 is reported. This is too large a task to be completed by one researcher and for that reason collaborations with other researchers have been sought. In order to explore the issues associated with this possibility, a methodology was developed and tested with PGCE students from Sheffield Hallam University.

6.3.3 Pilot study 2: Creating tasks to measure graphicacy levels
The pilot study was designed around the competency levels and relevant common areas of study of the students. The group was very diverse in terms of abilities, background and curriculum areas of focus. In total there were 24 Year 10 students brought together from the areas of Art and Design, Resistant Materials, Graphic Product, and Product Design. The students were described by their teachers as generally ‘having behavioural problems, 8 of
them having the drawing skills of 5 year olds, 5 of them were considered gifted and talented in drawing and 3 didn’t speak English’. After consulting experts from Loughborough University and the students’ teachers, it was decided to aim the activities at the initial most basic level and provide extension tasks which would allow the students to show progression and continuity of their knowledge and competencies.

Table 6.6 shows the common context identified by analysing AQA syllabuses and past papers in the four subject areas.

<table>
<thead>
<tr>
<th>Subject areas</th>
<th>Art &amp; Design</th>
<th>Resistant Materials</th>
<th>Graphic Products</th>
<th>Product Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areas of study</td>
<td>Create ideas based on a theme</td>
<td>Design ideas for 3 situations</td>
<td>Develop ideas based on a theme</td>
<td>Packaging design</td>
</tr>
<tr>
<td></td>
<td>Textures, surfaces</td>
<td>Textures, surfaces</td>
<td>Sketch – development of ideas</td>
<td>Materials and components</td>
</tr>
<tr>
<td></td>
<td>Observational drawing</td>
<td>Health and safety symbols</td>
<td>Design a symbol</td>
<td>Packaging symbols</td>
</tr>
</tbody>
</table>

Table 6.6 Common areas of study between the syllabuses

Table 6.7 shows the selected tasks from these common areas of study as defined by the taxonomy of graphicy (Figure 6.9). Rendering was selected as it is a useful skill for a number of areas of studies shortlisted in Table 6.6 i.e, to draw textures, surfaces and observational drawings in art and design; draw textures and surfaces in resistant materials; and to draw ideas for packaging designs (embossed features, finish of paper etc.) and other materials and components in product design. The colour co-ordination used in Table 6.6 and 6.7 shows the connection between the common areas of study between the subject areas and the element of graphicy chosen to be analysed during this pilot study.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Areas of graphicacy</th>
<th>Type of image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rendering material surfaces</td>
<td>Pictorial</td>
<td>Drawing</td>
<td>Well finished products that closely mirror an idea or observation</td>
</tr>
<tr>
<td>2 point perspective</td>
<td>Pictorial</td>
<td>Diagram</td>
<td>Technical diagram to clearly define features, details and/or requirements</td>
</tr>
<tr>
<td>Logo design</td>
<td>Symbolic</td>
<td>Abstract</td>
<td>Symbolic representation of information and warnings which convey messages/ ideas</td>
</tr>
</tbody>
</table>

Table 6.7 Pilot study tasks
Figure 6.9 A taxonomy for graphicacy

This category represents:

1. **GRAPHIC ART; PICTORIAL ART**
   - LIFE DRAWING
   - LANDSCAPE
   - PORTRAITS [1]
   - STILL LIFE

2. **DRAWING; PICTORIAL**
   - DRAFTS
   - SKETCHING
   - DRAWING

3. **DIAGRAMS; PICTORIAL**
   - ANNOTATED
   - ARCHITECTURAL
   - ENGINEERING / TECHNICAL
   - EXPLODED
   - PERSPECTIVE
   - PROJECTIONS (ORTHOGRAPHIC, OBlique, ISOMETRIC)

4. **SEQUENTIAL; LINEAL**
   - CARTOONS
   - STORY BOARDS
   - FLOW DIAGRAM
   - SPIDER DIAGRAM / BRAINSTORMING

5. **SYMBOLIC; QUANTITATIVE/ABSTRACT**
   - CHARTS and GRAPHS
   - SYMBOLS

6. **SYMBOLIC; SPATIAL**
   - MAPS
   - PHOTOGRAPHS
   - ADVERTISEMENTS [2]

7. **CAD (Computer Aided Design)**
   - COMPUTER AIDED IMAGES
   - 3D VIRTUAL IMAGES

To help people visually explore and understand themselves and the world around them, how they respond or feel about it. Usually the item produced is a finished product itself.

Well finished products that closely mirror an idea/observation. This is a means to achieve/get to the next stage.

Technical diagram to define clearly features, details and/or requirements such as relationships, processes, components.

Illustrate the sequence of a thought, process or story. Image follows a relative sense of direction.

Symbolic representation of data, information and/or warnings.

A representation of a message, a person, a scene or an area.

2 Dimensional and 3 Dimensional images created with the use of computer software.
6.3.4 Pilot study workshop implementation

The pilot study workshop lasted for 2 ½ hours. The students were provided with booklets which contained all the handouts and worksheets in the appropriate order, 2 different coloured pencils and one writing pencil. Students were shown how skills similar to the ones they were to be taught that day were used in industry and developed at university level. The rest of the workshop time was divided into three sessions, one per type of image. The sessions on rendering and symbols ran in a similar manner (Figure 6.10) as described below.

1. Students were asked to complete a task before any teaching occurred. Students were told what to do but not how to do it.
2. A lesson with PowerPoint slides and live demonstrations was run. Students had the opportunity to practise what was being learned by completing various tasks. The ratio between adults to students was approximately 1:3 which meant students had a lot of constant support during the lesson. This was significant as it provided students with a lot of opportunity to achieve their maximum potential.
3. At the end of each lesson, students were asked to complete the same task they had completed at the beginning of the lesson by themselves.

By the end of the sessions, the aim was to obtain a record of each student’s level and knowledge in each area prior to, during and after the lesson.
The session on 2 point perspective was run differently. The aim was to collect evidence of the students’ existing knowledge, learning progression and limitations. Each task was more complicated than the previous one with a higher level of difficulty (Figure 6.11).
6.3.5 Content of the pilot study sessions

The focus of the rendering tasks (Figure 6.12) was on the ability to colour-in realistically, basic shapes, taking into consideration the direction of a light source. The logo design was focused on using symbolic representations (Figure 6.13). For the perspective drawing task, the aim was to test the limits of the students’ abilities. Thus each task and exercise was building on the skills, knowledge and abilities learnt previously. The most challenging task students were asked to complete involved ‘cutting out’ pieces from cubes and rotating it in different directions (Figure 6.14). Table 6.8 shows the initial generic criteria that were developed to assess the above work. The criteria were developed having reviewed common textbooks and teaching and learning resources in relation with the above tasks. This was a starting point to assess students’ work with the expectation that these would be developed further through the pilot study.
Figure 6.12 Rendering: Stages of the lessons

1. Task a: Individual task
   Identify the light source and shade in the shapes

2. Lesson: Finished product
   Iron man trailer

3. Professional designers’ work: Rendering to create dramatic effects

4. Loughborough students’ work: High quality rendering

5. Demonstration: How to render shapes to show wooden, matt and shiny finish

6. Task b (exercise): Colour in the shapes to show wooden, matt and shiny finish

7. Task c: Individual task
   Identify the light source and shade in the shapes

Figure 6.13 Logo design: Stages of the lessons

1. Task H: Draw a logo for a water park called ‘Water world’

2. Lesson: Theory of different types of drawings and images

3. Class discussion: Analysis of existing logos

4. Task I: Draw a logo for a beauty salon and spa called ‘Heaven on earth’
Figure 6.14 Perspective: Stages of the lessons

<table>
<thead>
<tr>
<th><strong>Continuity and progression descriptors</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tasks</strong></td>
</tr>
<tr>
<td>Rendering</td>
</tr>
<tr>
<td>Difference shown in shading between the faces</td>
</tr>
<tr>
<td>The faces closer to the light source are lighter in colour</td>
</tr>
<tr>
<td>A gradient of colour used on each face to give a more 3D effect</td>
</tr>
<tr>
<td>Shadow added towards the opposite side of the light source</td>
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<tr>
<td>Logo designing (Symbolic representations)</td>
</tr>
<tr>
<td>Symbolic representations used including colours, images and forms</td>
</tr>
<tr>
<td>Feelings suggested i.e. fun, relaxation, luxurious, friendly</td>
</tr>
<tr>
<td>Company name represented</td>
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<tr>
<td>Perspective</td>
</tr>
<tr>
<td>Accuracy in using the technique chosen i.e. use of parallel lines correctly</td>
</tr>
<tr>
<td>Size; The object became smaller as its distance from the observer increases</td>
</tr>
<tr>
<td>Depth; Proper use of perspective (if chosen) i.e. lines converging onto a point</td>
</tr>
</tbody>
</table>

Table 6.8 Generic criteria developed as initial level descriptors
6.3.6 Methodology for analysing data:
Completed tasks were scanned in and the originals returned to the students with relevant feedback on future progression goals. The virtual copies were saved by replacing each student's name by a code identifying the relevant session, task number, and year-group, date of completion, gender and number of participant. Once the comparative analysis between students' work was completed, a list of descriptors for continuity and progression was drawn up (Table 6.9). The number of students achieving each descriptor was then counted in order to explore the possibility of sequences in the data.

<table>
<thead>
<tr>
<th>Rendering list of continuity and progression descriptors</th>
<th>Students’ work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task</td>
<td>Student 1</td>
</tr>
<tr>
<td>Descriptor 1</td>
<td>1a 1b 1c</td>
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<tr>
<td>Focus area 1</td>
<td>n/a 1c</td>
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<tr>
<td>Descriptor 2</td>
<td>n/a</td>
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<tr>
<td>Descriptor 3</td>
<td>n/a 1c</td>
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<tr>
<td>Descriptor 4</td>
<td>n/a 1c</td>
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<td>Descriptor 5</td>
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<td>Descriptor 6</td>
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<td>Descriptor 7</td>
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<td>Descriptor 8</td>
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<td>Descriptor 12</td>
<td>n/a 1c</td>
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<tr>
<td>Descriptor 13</td>
<td>n/a 1c</td>
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</tbody>
</table>

Table 6.9 Rendering: students' work analysis methodology

6.3.7 Methodological differences, strengths and weaknesses
The pilot studies have illustrated some of the different methodologies that will have to be employed for the main research.

Methodology to test graphicacy skills: The tasks to test graphicacy elements were designed with some differences according to the assumed level of difficulty of each task. For example, each task on perspective was created with a higher level of difficulty in comparison with the previous one. This was not the case with the tasks focused on logo design and rendering. The tasks focused on perspective began by testing skill which Year 10 students are expected to have; create 3 different sized cubes using a 3 dimensional method. It then continued by teaching and then testing a specific 3 dimensional method, 2 point perspective, which was
expected to be relatively new knowledge for most of the students based on their teacher’s initial comments. The session concluded with a more difficult task which required students to involve cognitive abilities as well as drawing abilities which were considered high and even challenging for the group of participating students. The structure of this lesson was designed in a way to test the assumptions on students’ existing knowledge, abilities and levels, and introduce their potential limitations.

A simpler method was used for the tasks created to test graphicacy skills in rendering and symbolic representations. Both areas were studied using a similar method, where the same tasks were used before and after the lesson (input). This was for two reasons;

1. It was considered that students’ abilities and existing knowledge was at a low level which would allow a noticeable change to be recorded after the lesson (input) without having to introduce a different task of a higher level of difficulty;
2. The skills and abilities required to complete these tasks at a high level are numerous and elaborate. The tasks were ‘open’ enough and potentially complicated enough to allow a wide range of abilities to be illustrated.

Methodology for analysing the results: The general method followed for analysing students’ work was the same for all tasks. A brief list of CaP descriptors was originally formed drawn from books, personal experience and through discussions with experts. Students’ work was gathered, scanned into the computer, their names cropped out of the drawings and replaced by a number. All the work was collated according to the exercise to allow for a range of work to be compared and analysed (Annex 4). During analysis of students’ work, the general list of descriptors was used (Figure 6.15) which was then extended, creating a more extensive and detailed list (Figure 6.16).
For the initial analysis of the results from the perspective and rendering tasks, the same method was employed to draw CaP descriptors and get an initial understanding of the skills and abilities of the students after the lessons. When dealing with the results gathered from the symbolic representation tasks, the results of the task given prior to the lesson and the task given after the lesson were combined. This was deemed necessary because the students illustrated different sets of skills and abilities in each task. The main purposes of these tasks were to identify what students can do at this age and draw CaP descriptors by comparing the outcomes of the students’ work of different standards.
6.3.8 Research within practice

A school in the UK volunteered to allow research to be conducted within the design and technology department. Current schemes of work were analysed, covering the subject areas of graphic products, resistant materials, systems and control, textiles, food technology, art and ceramics. Relevant opportunities for research and data gathering were identified for the period between October 2010 and February 2011 and were listed in a table form (Table 6.10). For example, through analysis of the scheme of work of the Year 9 Textiles Unit 1, an opportunity was identified for assessing the graphicacy element of art. The scheme of work required students to create a design which expressed them in some way. Via discussions with the teachers, appropriate tasks were developed enabling research data gathering while embracing current teaching and learning objectives. This ensured the effective and beneficial outcomes for all parties involved in the research conducted within practice. The tasks had valuable teaching and learning material to ensure the time students spent completing the tasks was as beneficial to them as it was for this study. The tasks were designed so either the teacher or the researcher could deliver them efficiently. These were matched across the areas of graphicacy as shown in Table 6.10, automatically shortlisting areas of graphicacy possible to be researched through this study. A note of the week (per academic term) each opportunity matched to was also noted. This would form another criterion towards the suitability of each research opportunity, as this study was completed under tight time schedule and limitation. In instances where the schemes of work did not provide a clear indication of the time plan, the letter ‘V’ was placed in the table to indicate that.
### Chapter Six: Research Methodology

<table>
<thead>
<tr>
<th>Project</th>
<th>Textiles: Year 9, Unit 1: Designing and making a hat for a commercial customer</th>
<th>3D Art: Year 7, Unit 2: Sweats and cakes, Basic representational drawing skills</th>
<th>Art: Year 7 Portraiture</th>
<th>Art: Year 7 World topics</th>
<th>Control: Year 7 Designing &amp; making a Plant Alarm</th>
<th>Art: Year 8 Pop art</th>
<th>Graphics: Year 7 Designing &amp; making a surface graphics for a personal mug</th>
<th>Textiles: Year 8 Designing &amp; making a cushion cover</th>
<th>3D Art: Year 8 &amp; Insects</th>
<th>Control: Year 8 Designing &amp; making an electronic game</th>
<th>Textiles: Year 8 Making a drawstring bag</th>
<th>Resistant materials: Year 8: Wooden container/CAD CAM lid</th>
<th>Resistant materials: Year 9: Novelty Clock</th>
<th>Resistant materials: Year 7: Puzzles &amp; Games</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphic arts</td>
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<td>Week 10</td>
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Table 6.10 Identifying research opportunities within existing schemes of work

<table>
<thead>
<tr>
<th>Symbols</th>
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<td>Computer aided images</td>
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<td>3D virtual images</td>
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Table 6.10 Identifying research opportunities within existing schemes of work
This research was carried out between the 23\textsuperscript{rd} of November and 16\textsuperscript{th} of December 2010. During this time, a number of opportunities for research were identified and proposals for a methodology were prepared.

The relevant members of staff were then contacted through email. The structure of the letter/e-mail (Appendix 4.6) sent out was as follows:

1. An introduction of this researcher’s area of interest. The aims, objectives and importance of the research. A summary of relevant prior discussion with the head of the department was provided.

2. A description of their department’s schemes of work, analysed for the purpose of this research was provided along with an explanation of Table 6.14. Potential methodologies to be followed were described such as; observing lessons, leading/teaching lesson inputs etc. A description of the analysis methodology was also provided (i.e. scanning or photocopying students’ work).

3. The time-frame for this research (within-practice) was clarified.

4. A list of potential benefits for each individual teacher taking part in this study was drawn up i.e. free new teaching aids, free-up some of their teaching time etc.

5. Organising an initial meeting to discuss potential collaboration plans.

Appointments were made for individual meetings, to discuss in more detail potential collaborations. Resources from pilot study 2 were used as an example to explain the methodology clearly. All teachers agreed to allow this researcher to carry the research by teaching part or whole hour lessons. The tasks proposed were designed to enhance the lesson instead of interrupting it.

After discussions with the relevant teachers and further preparation, a number of case studies were conducted in the school. These looked at the following elements of graphicity: isometric drawing (Year 8); flow diagrams (Year 9); story board (Year 8); top view/bird’s eye view focusing on shapes (Year 7); bird’s eye view focusing on shape and proportions (Year 8); cartoons, caricatures and portraits (Year 7) and star profiles (Year 7). Data gathered from 2 sessions; star profiles and portrait drawings, were considered to be worthy of being analysed for this thesis due to a number of reasons:

1. Star profile; a type of graph within the Symbolic category.
   Students were fully engaged with the tasks during the lesson. Relating to the complexity levels of understanding and creating these images, the star profile is presumed to be one of the less complicated types of images. In addition, analysing this image provided a first inside into a different, more technical type of image.

2. Portraits; an image within the Western Art category.
   Very good results were gathered during this session. All students worked really hard and it was clear during the lesson that the children were achieving the best they
could at that time. The results showed a clear progression of understanding and knowledge which enabled the analysis and drawing of the CaP descriptors.

Lesson plans were produced for each session. The duration of each lesson varied according to the needs of the study and the opportunities offered by the school. The methodology for conducting each case study is shown through the lesson plans.

6.3.9 Case study 4 implementation: Star profile

The following study was a 30 minute intervention during a lesson in food technology. This study was repeated with 2 classes (23rd November 13:20-14:20 and 24th November 9:00-10:00). The task prepared for this session increased in an assumed level of difficulty as the lesson went on (Figure 6.17). For each task, the students were firstly asked to draw the star profile individually without adult help. The area was then discussed and the correct solution illustrated and explained. The students where then asked to draw the correct solution. Help was provided were necessary. The first task relating to a 4 elements star profile was different from the rest as it was an area previous taught to the students. Task 2 was focused on creating an 8 elements star profile using set squares. Task 3 was focused on drawing a 6 elements star profile and Task 4 was a comparative star profile, where multiple product evaluations were drawn on a 4 elements star profile. A lesson plan for this lesson is provided in Appendix 4.7.

![Figure 6.17 Star profile tasks](image)

6.3.10 Pilot study 3: Portrait drawing workshop

A curriculum day at the school provided the opportunity to run a day’s workshop with one class. After brainstorming ideas, it was decided to focus on portrait drawings. The decision was based on the following criteria:
• work on an element of graphicacy from a category that has not been covered at all so far;
• ensure it is within the abilities of Year 7 students;
• include fun activities for the students;
• create a challenge for the students;
• gather enough information to allow for analysis and comparison leading to graphicacy descriptors.

6.3.11 Pilot study preparation
Not having much knowledge on how to draw portraits, this researcher's position to develop, organise and run the workshop was ideal. This was due to the fact that this researcher would have to experience for the first time all the stages the participants would have to go through during the lesson. A number of guiding instructions and resources were found through literature and online. Due to the nature of this situation, personal experience and judgement was used to identify the most suitable resources. Thorough preparation was completed in advance, until the basic understanding of drawing portraits and its communication were achieved. Male and female general portraits with a variety of cartoon facial expressions and caricatures were created (focusing on the face).

6.3.12 Case study 3 implementation
To ensure the success of this once-in-a-year opportunity, the methodology was tested during a pilot study. The participants were much older (between 20-28 years old) than the participants in case study 5 (11-12 years old). The structure of the method was expected to be the same for both groups. The difference was expected to be found in the quality of work.
There were 5 participants:
1. Male, 28 years old, art teacher in a secondary school, described his drawing abilities as very good.
2. Male, 27 years old, PhD student from the Aeronautical Engineering department, described his drawing abilities as ‘awful’.
3. Female, 24 years old, training to be a cook, described her abilities to draw as ‘ok’.
4. Female, 22 years old, MA student in Theatre studies, described her abilities to draw as ‘good’.
5. Male, 20 years old, undergraduate student, described his abilities to draw as ‘awful’.

The session ran for 5 hours with a 45 minutes break in between. The sequence of tasks is described in Figure 6.18. Resources were developed to assist the flow of the lesson.
These included:
• Plain A4 paper for Tasks 1, 3 and 6
• Handouts with guidelines for Tasks 2, 4, 5 and 7
• For visual stimuli and inspiration, handouts with images gathered from the web were provided covering: cartoons and caricatures with a focus on facial expressions (Annex 5).

Figure 6.18 illustrates the sequence of the lesson followed

6.3.13 Case study 4 implementation: Portrait drawings

The lesson took place on the 7th of December, 2010. Twenty one, Year 7 students took part in the full curriculum day which was focused on portrait drawings. A similar methodology was used as in the pilot study 3. The lesson plan in Figure 6.19 provides the structure of the lesson. The tasks focused on drawing the face from various angles was deemed to be challenging for introducing in this lesson. Tasks increased in difficulty level as the lesson progressed. The students were introduced to the day's events and lesson plan, aims and objectives. At the beginning of the lesson, students were asked to draw a (random) portrait.

The lesson began with technical information, focused on how to divide up the space within a face according to the size and location of key features i.e. hair line, eyebrows, eyes, nose, mouth, chin and ears. The general shape of each facial characteristic was studied, and then
drawn in the correct place (to form a face). The following task required the students to draw a portrait using the basic rules learned before and to make small changes to each feature according to a photograph of a man or woman provided for them.

The next task was similar to the last, only small changes to the features were made according to their reflection in a mirror, i.e. drawing a self-portrait.

The last part of the lesson was designed to be more relaxed and creative. After long hours of hard work, students were shown how to create cartoon characters, focusing on facial expressions. The next stage was focused on turning cartoons into caricatures. Only the students interested in this area took part in the lesson. The rest continued working on their cartoons. This part of the lesson provided a lot of data which have not been included in this thesis. This was due to the change in teaching style during the end of the session. Students had been working very hard for many hours and it was obvious that even though they were still willing to work, they were tired. Therefore the last part of the lesson was carried out in a more relaxed and less controlled environment. A full lesson plan is provided in Appendix 4.8.

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![Profile drawings lesson plan](image)

Figure 6.19 Profile drawings lesson plan
6.4 Collaborations

6.4.1 Pilot study 4: Co-research

Research collaboration began with the PGCE students from Sheffield Hallam University. The students were given an action research assignment to complete for their course, with an open focus area. The students had the opportunity to attend a seminar where they were briefed in the area of graphicacy and the aim of this current research. A clear comparison between their assignment and the way they could contribute to this research was provided. Table 6.11 gives the structure of that seminar.

<table>
<thead>
<tr>
<th>The seminar covered the following areas:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What is graphicacy?</td>
</tr>
<tr>
<td>2. A taxonomy for graphicacy</td>
</tr>
<tr>
<td>3. Graphicacy in the curriculum</td>
</tr>
<tr>
<td>4. Graphicacy in the curriculum of a school in Cyprus and a school in the USA</td>
</tr>
<tr>
<td>5. Task 1 – identify the type of each image according to the taxonomy (images were taken from Greek text books to enable students to use only visual communication skills to classify the images) (Figure 7.13)</td>
</tr>
<tr>
<td>6. Contradictory opinions on the development of graphicacy in humans, part of a literature review</td>
</tr>
<tr>
<td>7. KS3 National Curriculum analysis, identifying where graphicacy is involved and what aspects of the taxonomy are required for each level (Figure 7.14)</td>
</tr>
<tr>
<td>8. Graphicacy within design and technology</td>
</tr>
<tr>
<td>9. Pilot study review: areas covered, how it was implemented,</td>
</tr>
<tr>
<td>10. Analysis of initial results and defining continuity and progression descriptors (Figure 7.15 and 7.16)</td>
</tr>
<tr>
<td>11. Collecting research data (Figure 7.17)</td>
</tr>
<tr>
<td>12. Collating the research data (Figure 7.18)</td>
</tr>
</tbody>
</table>

Table 6.11 Sheffield Hallam University PGCE students’ session 1 content

To familiarise the students with the taxonomy and the different types of images, students were asked to complete a task (Figure 6.20). A number of images with Greek text were taken from within the design and technology discipline, and students were asked to identify the type of image with regards to the taxonomy.
**Figure 6.20 Task: Classify the type of each image**

<table>
<thead>
<tr>
<th>Task 1</th>
<th>Images taken from various DT subject areas. They are in Greek! Have a guess at the type of image and the subject area they are from. Complete the table on page 4.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>1. Instructions</th>
<th>2. The digestive system</th>
<th>3. CD rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Patterns</td>
<td>5. Alarm system</td>
<td>6. Poster</td>
</tr>
<tr>
<td>10. Cabinet</td>
<td>12. Rendering</td>
<td></td>
</tr>
</tbody>
</table>

| **Subject Areas vs Types Of Images matrix** |
| Identify the type of each image and write the relevant number in the table below |

<table>
<thead>
<tr>
<th>GRAPHIC ARTS</th>
<th>Resistant materials</th>
<th>Graphic products</th>
<th>Electronic products</th>
<th>Textiles</th>
<th>Food technology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Art</td>
<td>Life drawing</td>
<td>Still life</td>
<td>Portraits</td>
<td>Landscape</td>
</tr>
<tr>
<td>DROUNT</td>
<td>Drafts</td>
<td>Sketching</td>
<td>Drawing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIAGRAMS</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEQUENTIAL</td>
<td>Cartoons</td>
<td>Storyboards</td>
<td>Floor diagrams</td>
<td></td>
<td></td>
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<tr>
<td>ABSTRACT SYMBOLIC</td>
<td>Charts &amp; Graphs</td>
<td>Symbols</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPATIAL</td>
<td>Maps</td>
<td>Photographic</td>
<td>Advertisements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Aided Design</td>
<td>3D virtual Images</td>
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</table>
A curriculum analysis task was conducted designed to reinforce the case of the importance of graphicy as a new research area. The aim was to inform the students of the problems stemming from the lack of identification and classification within the National Curriculum with regards to graphicy and graphicy levels. Figure 6.21 was used to emphasise this message as well as act as part of the students’ research assignments.

![Figure 6.21 Task KS3 National Curriculum Analysis](image)

A description of how the CaP descriptors were originally formed was then given, and by following an analysis of the results (as shown previously in Figure 6.28), a more extensive and detailed list of the descriptors was developed. Students were guided through this process for the first example (rendering session) and were then asked to develop the lists of CaP descriptors for the other two sessions (2 point perspective and logo design and symbols) during class discussion.

Students were also briefed on an appropriate way of collecting research data. It is important that all students follow the same format in order to enable future data collation. The students were asked to create a code for each student incorporating the year group, the researchers’ initials, and the number corresponding to the student’s name on the class register. Students were also encouraged to collect other information for each student to allow for further comparison such as gender, the marks of the latest report for each or some subject areas, homework behaviour and class participation (Figure 6.22).
Students were advised to keep a thorough record of their work and all of their students’ work. To achieve useful results from this research, students should aim to work with pupils from at least two different year groups on each type of image. This would enable a distinction to be drawn between the abilities of i.e. Year 7 and Year 9 students concerning the same type of image.
Graphic representations were produced as samples to show some of the ways students can bring their data together to observe patterns and allow for easy comparison (Figure 6.23).

Figure 6.23 Collating research data

Figure 6.24 shows the main stages of communication between this author and the PGCE students.

<table>
<thead>
<tr>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main seminar: aim of the research and background information</td>
<td>Step-by-step review: responding to the course assignment on action research</td>
<td>Individual discussions and first drafts on initial thoughts, ideas, possibilities and plans</td>
</tr>
</tbody>
</table>
6.4.2 Case study 5: Co-research

In 2011 a similar seminar was given to the PGCE students of Sheffield Hallam University. The same methodology was followed as the year before. The context of the seminar was the same in relation to introducing graphicacy and co-research. The research focus however, was shifted on cross-curricular links and graphicacy across the curriculum. Students were provided with teaching aids in the same manner as in the previous year during and after the seminar (all teaching material was posted online on the official website of their course). The students worked independently after the seminar. Only a small number of emails were exchanged with 2 students for further reading and initial support. The results of the students’ work will not be included in this thesis as their submission deadline is after the completion of this thesis.

6.4.3 Interrater reliability

The interrater reliability of the taxonomy was tested a number of times over the 3 years of study, presented in a number of contexts. The exercise illustrated in Figure 6.20 is one example of the method used to test the taxonomy and interrater reliability. In some instances, co-research has also been tested and validated as a methodology. These were done at the:

- DATA 2010 international conference. More than 30 academics, researchers and teachers tested the taxonomy. The area of co-research was also presented and discussed. Feedback was collected in writing at the end.
- PGCE seminar 2010 on action research and graphicacy. Around 80 Master level and PGCE students took part in the exercise using the taxonomy. Action research was presented and discussed.
- One PGCE student used the taxonomy to pursue research in her school on CaP descriptors. By this, both the taxonomy and the co-research methodology were tested and validated.
- PGCE seminar 2011 on co-research and graphicacy. Around 50 PGCE students were involved in a similar way as in 2010.
- Experts on visual literacy from Cyprus, UK, USA and Sweden reviewed the taxonomy during the Delphi study group.

6.4.4 Delphi technique

The Delphi method is considered to be a systematic interactive forecasting method formed by a group of experts, ‘effective in allowing a group of individuals to solve complex problems’ (Linstone & Turoff, 1975:3). It is based on the assumption that group judgments are more valid than individual judgments. Experts are asked to give their opinion (otherwise known as ‘forecasts’) on the issue at hand, which is clearly explained in an appropriate form, varying from questionnaires to open questions. Answers are collate; processed and any irrelevant comments are filtered out. Common and conflicting viewpoints are identified. The outcome is then sent back to the experts who comment on their own forecasts, the responses of others and on the progress of the panel as a whole. Results are processed again by the panel director and sent out for further review (Figure 6.25).

![Figure 6.25 Visual representation of the Delphi technique](image-url)
This avoids the negative effect of face-to-face panel discussions and resolves any issues concerning group dynamics. Usually all participants remain anonymous which allows them to freely express their opinions and encourages them to openly critique and revise earlier judgments.

6.4.5 Implementing the methodology for Delphi group study

Networking during international conferences and previous collaborations provided a number of appropriate professionals who could act as members of the Delphi group study. Eighteen people were contacted initially through email (Annex 6). These included professors, lecturers, academics and educationalists amongst other from the UK, USA, Cyprus and Sweden.

The main areas of focus for the Delphi group were:

- Appropriateness of Delphi study methodology proposed;
- Appropriateness of the taxonomy of graphicacy as a research tool
- Cross-curricular links (part of this PhD study results);
- Rendering CaP descriptors;
- Perspective drawing CaP descriptors;
- Overall Delphi study outcome.

The first letter, which was sent out in the form of an email, was inviting each individual to participate in the Delphi study group. The focus of the study was clarified; validating the methodology used and the CaP descriptors of graphicacy drawn. Graphicacy was defined and its importance was outlined. A summary of this researcher’s work on graphicacy was provided and the main focus of the research described. A personalised paragraph was added explaining why the individual was selected to take part in the study and how they could possibly benefit from participating. The layout of the study was described i.e. a document introducing the new area of discussion was provided for each round, along with a questions sheet which applicants were encouraged to fill in and send back. From round 2 of discussions onwards, an additional document summarising areas of concern raised in the previous discussion was provided, along with an executive summary and a table of actions taken. The 3 areas of interest for this study were outlined; the taxonomy, cross-curricular links and CaP descriptors. The time frame available for this study was also clarified and a one week deadline for all responses was given. The methodology was tested in round 1 of discussions, and was then followed for the remaining rounds. The only change made after the first round, was the format of documents sent out. The question sheet was sent out in a Word Document format instead of a pdf. All the documents sent during the Delphi study group can be found in Appendix 4.9. These include the emails sent out (shown in a letter form), introduction of each new area for discussion, previous round results and the question sheet.
6.4.6 Delphi study group questions

All questions were designed in a similar manner. Each question was numbered and responses were asked for in two areas; (1) agree/disagree (Yes/No answers) and (2) Provide a comment.

The questions sent out are listed below:

Round 1 of discussions

- Question 1: Do you think the Delphi group method described is appropriate/doable?
- Question 2: (A figure was provided illustrating the categories of the taxonomy of graphicity. The elements within each category were included along with a written description). Are the categories the ones you would expect? Please indicate if you consider each category appropriate or not, by ticking the relevant box next to the title of each category.
- Question 3: Are there any elements which you feel have been missed out?

Round 2 of discussions

- Question 1: Do you think version 2 of the taxonomy is a comprehensive and appropriate research tool for research in an educational context with regards to the types of images and the graphicity skills (the ability to communicate [code & decode] information through still visual images) required to deal with them?
- Question 2: Do you think breaking up the taxonomy into 25 types of images was the appropriate method for a research tool to be used in the study described above?
- Question 3: Is there anything within the results illustrated in the figure (a figure was provided illustrating the cross-curricular links) which is unexpected?
- Question 4: Do you think the cross-curricular links identified are equally appropriate for inbound and outgoing graphicity skills (coding and decoding information)?
- Question 5: Is there a difference between the level of difficulty in dealing with coding and decoding the same type of image?
- Question 6: Do you think one can acquire outbound graphicity skills (coding/creating an image) without having obtained the required inbound graphicity skills (decode, read and understand information) relating to the same type of image?

Round 3 of discussions

- Questions 1: Is the methodology presented in the attachment ‘Delphi group discussion 3 Rendering descriptors’ for gathering data within practice, appropriate?
- Questions 2: Could this research strategy develop an understanding of progression in this element (rendering) of graphicity?
- Questions 3: Do you think the descriptors generated would be useful during assessment for learning relating to rendering?
• Questions 4: (The final list of descriptors was provided); would you add, remove or change the order of any of them?
• Additional/ general comments:

Round 4 of discussions
• Questions 1: Is the methodology presented in the attachment ‘Delphi group discussion 4: Perspective drawing descriptors’ of gathering data within practice, appropriate?
• Questions 2: Could this research strategy develop an understanding of progression in this area (perspective drawing) of graphicacy?
• Questions 3: Given that these descriptors were developed through specific tasks, could they be used more widely for assessment for learning relating to the basic understanding of drawing cuboids freehand and using 2 point perspective?
• Questions 4: Below is the final list of descriptors for perspective. Would you add, remove or change the order of any of them?
• Questions 5: Do you think the descriptors under the title ‘basic technique for 2 point perspective could also be applied when working with 1 point perspective’?

In the light of round 3 discussion and feedback
• Questions 6: In the light of this feedback, do you think the task was appropriate?
• Questions 7: Would you suggest using more fluid forms as a starting point for introducing the concept of rendering?
• Questions 8: Do you have a specific age range in mind for the above suggestion?
• Questions 9: Do you think it would be appropriate for year 7 students (ages 11-12)?
• Questions 10: Can young students go straight into understanding the philosophy of rendering by working on more fluid forms?
• Questions 11: Do you think adding shadow correctly according to the distance of the light source is more or less difficult than adding shadow to suggest the correct form of the shape (A figure illustrating the 2 was provided)

Additional/ general comments:

Round 5 of discussions
Round 5 did not contain a question sheet as it was used as the conclusive round summarising the outcome of the entire Delphi study.
6.4.7 Delphi study group participants
The list of participants invited to take part to the Delphi study group included:

- A member of the Organisation of Secondary School Teachers of Cyprus
- An active teacher and employee of the Ministry of Education and Culture, Cyprus for Primary and Secondary Education industry
- An Associate Professor from the University of Cyprus, Board member of the International Visual Literacy Association
- A Design and Technology Inspector at the Ministry of Education and Culture in Cyprus
- An active Primary school principal in Cyprus
- The President of Distance Learning Division at AECT, Assistant Professor at DePaul, with specialties: Distributed and Online Learning; Visual Literacy; Action Research
- The Vice President of the International Visual Literacy Association, Research Assistant at McGill University, Newsletter Editor for the Department of Art History and Communication Studies
- The President of the Association for Educational Communications and Technology, Assistant Professor and Instructor at Colorado State University, Executive Treasurer at the International Visual Literacy Association, Board Member of the association for Educational Communications and Technology
- An active educationalist, visiting lecturer at Loughborough University, experience educator, experienced Advanced Skills Teacher
- A visiting lecturer at Loughborough University, considered to be an authority on children’s learning patterns and the role of creative play in early development
- The Programme Leader for PGCE/MSc Design and Technology Initial Teacher Education department of a UK university, experienced Ofsted Inspector and Accredited Trainer for the Electronics in Schools Strategy. An External Examiner and a Faculty Advisor for the Open University.
- The Programme Leader for PGCE/MSc Design and Technology Initial Teacher Education department of a (different) UK university
- A member of the Council of Management governing the D&T Association
- Professor of information technology from Sweden, writer of more than 60 books and 200 journal articles, focused on aspects of communication, design, learning, media development and visual communication.
6.5 Chapter 6 summary

The focus of this chapter was on reporting the methodology adopted in every pilot and case study and subsequent data gathering activities, during this research. These are presented following the sequence of studies as they were completed. Table 6.12 presents a summary of all the studies conducted, with each relevant research focus.

<table>
<thead>
<tr>
<th>Research focus area</th>
<th>Pilot studies</th>
<th>Case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphicacy across the curriculum</td>
<td>Pilot study 1: Analysis of textbooks in Cyprus</td>
<td>Case study 1: Analysis of textbooks in the USA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Case study 2: Analysis of textbooks in UK</td>
</tr>
<tr>
<td>Graphicacy continuity and progression descriptors</td>
<td>Pilot study 2: Workshop on rendering, perspective and logo design</td>
<td>Case study 3: Star profile (research within practice)</td>
</tr>
<tr>
<td></td>
<td>Pilot study 3: Star profile</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pilot study 4: Workshop on portrait drawings, cartoon and caricatures</td>
<td>Case study 4: Portrait drawings (research within practice)</td>
</tr>
<tr>
<td>Collaborations</td>
<td>Pilot study 5: Co-research with PGCE students (2010)</td>
<td>Case study 5: Co-research with PGCE students (2011)</td>
</tr>
<tr>
<td></td>
<td>Pilot study 6: Delphi study group Round 1 of discussions</td>
<td>Case study 6: Delphi study group Rounds 2-5 of discussions</td>
</tr>
</tbody>
</table>

Table 6.12 A summary of the studies conducted

A naturalistic research approach has been followed with the primary focus on the gathering of qualitative information. A summary of the methodology followed for the first research focus; identifying graphicacy across the curriculum is provided in Figure 6.26.
The second area of focus for this study was the identification of descriptors for different elements of graphicacy. The methodology followed for the pilot studies and case studies conducted are presented in Figure 6.27. The general methodology piloted during the pilot study 2 was followed and implemented for pilot study 3 and case studies 3 and 4. The flow diagram in Figure 6.27 initially gives the stages of the methodology indicating clearly the different stages. When the same methodology is repeated in the next studies, the stages are illustrated in a simpler manner.
Two main collaborations were formed during this research: co-research and a Delphi study group. Co-research was formed with 2 successive PGCE student year groups over the period of 2010 to 2011. The first was treated as a pilot study, testing the methodology and the concept (of co-research). The findings are reported in chapter 7. The second collaboration with the PGCE students is referred to as case study 5. The results of this case study will not be reported in this thesis. Students involved with this co-research, would have to submit their results (part of their course) after the completion of this thesis.
The Delphi study group was used as a method to validate some of the methodology and result of this study. The first round of discussions was treated as pilot study 5 and the other rounds of discussions as case study 6. Figure 6.28 illustrates the methodology and implementation of these collaborations.

Figure 6.28 Co-research and Delphi study group methodology and implementation
CHAPTER SEVEN

Results

Introduction to Chapter 7

Chapter 7 is divided into 3 main sections with an overall summary at the end forming a fourth, smaller section. Section 7.1 is focused on graphicacy across the curriculum; section 7.2 is on the results for continuity and progression descriptors and section 7.3 on the results from the collaborations built during this study. The first section (section 7.1) begins with reporting the results on graphicacy across the curriculum, broken down into 2 main parts; Section 7.1.1 is focused on the modification and validation of the taxonomy resulting from the interviews with academics, methodology review and the Delphi study group. Sections 7.1.2, 7.1.3 and 7.1.4 are focused on the results of the final methodology used for pilot study 1 conducted in Cyprus, case study 1 conducted in the USA and case study 2 conducted in the UK, respectively. The overall results on graphicacy use across the curriculum along with cross-curricular links are then presented in section 7.1.5.

The results from the second section of the main study focused on continuity and progression descriptors are reported in section 7.2. The section starts with part 7.2.1 reporting the results from the workshop (pilot study 2) focused on rendering, perspective and symbolic representations. Results based on students’ work completed during the study are reported and a final list of descriptors is provided for each area of the taxonomy studied along with the results from the Delphi study group for the rendering and perspective results. The methodology for analysing the results and validation from the Delphi study group is included. Pilot study 3 and case study 3 results on star profile images are reported in part 7.2.2. The results from pilot study 4 on portrait drawings methodology and case study 4 on portrait drawings are reported in parts 7.2.3 and 7.2.4.

The chapter then continues with reporting the results on the collaborations formed during this study. Parts 7.3.1 (pilot study 5) and 7.3.2 (case study 5) report the results on co-research as a methodology. The results from pilot study 6 and case study 6 on the Delphi study group as a methodology are reported in part 7.3.3. A summary of all of the above information is included in the summary section.
7.1 Graphicacy across the curriculum

7.1.1 The taxonomy of graphicacy

Interviews with academics: Validating the taxonomy

The taxonomy of graphicacy is treated as a work in progress. Over the period of the 3 years, the taxonomy has gone through a number of changes (refer to section 6.6.2 for methodology). In 2009, three academics challenged the categories until satisfied with the reasoning behind it. The one category that was under scrutiny the longest was the category of CAD (Computer Aided Design). The main argument was that computer aided images did not necessarily form a different type of images from the ones already categorised. They were merely completed using different media. The reasoning behind this category is that although when reading information from an image made using CAD, the skills and abilities required would be the same as if the image was created using any 2-dimensional media. The main differences come when creating the image (using outgoing skills). The skills and abilities to create the image depend heavily on the sophistication and complexity of the software package used. It was agreed that it is too important to ignore the category as it is so widely used and yet too complicated and diverse to be looked at in depth in this research.

This resulted in placing the category of CAD images as a separate category within the taxonomy. All 3 academics approved of the taxonomy for graphicacy and suggested further literature on relevant areas.

Version 1 of the taxonomy (Figure 6.3, created as a result of the interviews with the academics) was used during pilot study 1 and case study 1. After analysing the results gathered from the Cypriot (pilot study 1) and the USA school (pilot study 1), the element of graphicacy labelled as ‘annotated’ was removed from the taxonomy. Looking at the type of understanding required for one to read and understand or to create such an image, annotated diagrams did not offer sufficient unique characteristics to be classified as a graphicacy element. Any type of image could be annotated, incorporating literacy and/or numeracy and graphicacy. This was considered to be a secondary action. The primary action would be the creation of the image, which could include any element of graphicacy. For this reason during the collection of the results from case study 3 (the UK school), no evidence was gathered on the use of annotated images. The taxonomy was further developed at a later date, during the Delphi study.
Delphi group discussions: Validating the taxonomy

Round 2 of discussions was focused on the taxonomy and the methodology of the Delphi study group. There was a positive reaction towards the first discussion area relating to the taxonomy of graphicacy. The feedback from the Delphi study group suggested the approach to be ‘interesting and useful’, and ‘(also) because the taxonomy is, and should be a work in progress. This is an efficient way of gathering a variety of up-to-date views on the subject’. The ‘thrust of the categories is clear’ as ‘(it is) complete in terms of categories’ and the category description ‘explains the distinction between the categories’. Another area requiring further specification revolves around the images and categories used which are derived from Western culture. This is because ‘the research methodology (has been developed to) conduct (research) in the Western educational establishments. (In addition, a large quantity of the) literature about progression and development found has been Western’. It is also apparent that a different ‘literature tradition’ is associated with the area of information design, which can add new insights to the research.

Table 7.1 is a summary of the Delphi study group results. The areas of concern raised by the Delphi study group relating to the taxonomy of graphicacy and the action or response taken as a result for each one are listed below. Any modification to the work completed as a result of an area of concern raised, are briefly summarised in the table. Certain areas of concern, however, required only further explanation to support their validation. In the table below these are summarised as ‘explained in the detail discussions area’. All responses and actions taken are described in detail in Appendix 4.9

<table>
<thead>
<tr>
<th>Areas of concern</th>
<th>Response/ action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is there a hierarchy within the elements of the taxonomy</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>2. Why this taxonomy?</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>3. 24+ categories instead of 8 larger groups</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>4. Multi-layer meanings of an image</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>5. Tension between ARTS category and sub-categories</td>
<td>Taxonomy modified</td>
</tr>
<tr>
<td>6. Do spider diagrams have a direction of information flow?</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>7. What type of understanding is required to decode CARTOONS?</td>
<td>Taxonomy modified</td>
</tr>
<tr>
<td>(question raised by this author)</td>
<td></td>
</tr>
<tr>
<td>8. Why are Charts &amp; Graphs grouped with Symbols?</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>9. Photographs; too prevalent to be grouped</td>
<td>Taxonomy modified</td>
</tr>
<tr>
<td>10. Which images are included in the CAD category?</td>
<td>Explained in the detail discussions area</td>
</tr>
</tbody>
</table>

Table 7.1 Areas of concerns & responses
Figure 7.1 illustrates the revised taxonomy (Version 2) which resulted from the first round of the Delphi group discussions. The writing in red indicates what has been removed. The writing in green indicates the new additions to the taxonomy.
A Taxonomy of Graphicacy
(version 2)

PICTORIAL: WESTERN ART
- LIFE DRAWING
- LANDSCAPE
- STILL LIFE
  - Representations from an individual artistic perspective.
  - Usually the item produced is a finished product itself.
  - To be decoded, the observer needs to interpret these images within the artist's cultural, educational or professional context.
- PORTRAITS
- OTHER COMPOSITIONS

PICTORIAL: DRAWING
- DRAFTS
- SKETCHING
- DRAWING
  - Products finished to an appropriate level of accuracy to closely mirror an idea/observation.
  - This is often a means to achieve/get to the next stage.
  - To be decoded the observer needs to identify the idea/observation.

PICTORIAL: DIAGRAMS
- PERSPECTIVE
- ARCHITECTURAL ENGINEERING TECHNICAL
  - Technical diagrams to define clearly features, details and/or requirements such as relationships, processes, components.
  - To be decoded, the observer has to have developed the relevant spatial abilities and understanding of the technique.
- EXPLODED
- PROJECTIONS

PROJECTIONS (ORTHOGRAPHIC, OBLIQUE, ISOMETRIC)

SEQUENTIAL
- STORY BOARDS
- FLOW DIAGRAM
- SPIDER DIAGRAM/BRAINSTORMING
  - Images which illustrate the sequence of a thought, process or story.
  - Information follows a relative sense of direction.
  - To be decoded, the observer needs to be able to identify the flow of information.
<table>
<thead>
<tr>
<th>SYMBOLIC; QUANTITATIVE/ABSTRACT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHARTS &amp; GRAPHS</strong></td>
<td><strong>SYMBOLS</strong></td>
</tr>
<tr>
<td><img src="image" alt="Charts &amp; Graphs" /></td>
<td><img src="image" alt="Symbols" /></td>
</tr>
<tr>
<td>Symbolic representation of data, information and/or warnings.</td>
<td>To be decoded the observer must recognise and make connections between the data and/or information represented.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMBOLIC; SPATIAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAPS</strong></td>
<td><strong>ADVERTISEMENTS</strong></td>
</tr>
<tr>
<td><img src="image" alt="Maps" /></td>
<td><img src="image" alt="Advertisements" /></td>
</tr>
<tr>
<td>Representations of a message, a person, a scene or an area.</td>
<td>To be decoded the observer must recognise and make connections between the messages represented.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PHOTOGRAPHIC</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHOTOGRAPHS</strong></td>
<td><img src="image" alt="Photographs" /></td>
</tr>
<tr>
<td>Relating to photographs, especially representing or simulating something with great accuracy and fidelity of detail.</td>
<td>To be decoded the requirements might include any of the above, but the capabilities required to create them depends on the hardware and software used.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAD (Computer Aided Design)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMPUTER AIDED IMAGES</strong></td>
<td><strong>3D VIRTUAL IMAGES</strong></td>
</tr>
<tr>
<td><img src="image" alt="Computer Aided Images" /></td>
<td><img src="image" alt="3D Virtual Images" /></td>
</tr>
<tr>
<td>2 Dimensional and 3 Dimensional images created with the use of computer software.</td>
<td>To be decoded the requirements might include any of the above, but the capabilities required to create them depends on the hardware and software package.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OTHER</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Games, Crosswords, Puzzles etc.</td>
<td><img src="image" alt="Other Miscellaneous Visual Images" /></td>
</tr>
<tr>
<td>Other miscellaneous still visual images.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7.1 Revised taxonomy of graphicacy (Version 2)
General comments from the Delphi study round 2 of discussions on the revised version of the taxonomy

- A key has been added on the top right hand side to aid (Figure 7.1) in identifying the changes made on version 2 of the taxonomy. In the final version of the taxonomy, no colour coding will be used for the font at any point, and that key will be removed.
- The title ‘This category represents’ has been changed to ‘category description’ for succinctness. The descriptions under this section have been revised to be more precise and clear.
- Literature has clearly identified the possibility for all subcategories to be expanded further. For example, charts and graphs can be broken to specific types of charts – Gantt charts, pie charts, bar charts etc. Such information has not yet been added, because there has been no requirement from the scope of this research. This applies to all of the categories included in this taxonomy i.e. maps, diagrams etc.

Delphi group round 3 of discussions relating to the taxonomy and the methodology of the Delphi study group

Feedback from the Delphi study group reported that the changes made to Version 2 of the taxonomy ‘definitely improved the taxonomy, showing the value of the Delphi process’. ‘The new version of the taxonomy is in a much better shape and more understandable due to the new information that has been incorporated’. It has been agreed by a number of participants that ‘this is work in progress. The intended use of the taxonomy forms an important statement to be incorporated within the table illustrating the taxonomy.

After further consideration and though following the second round of discussion on the taxonomy, another small change has been made regarding the category of advertising shown in Figure 7.2 of Version 3 of the taxonomy. This has now been placed under the main titles of ‘SYMBOLIC; QUALITATIVE’, named ‘ADVERTISING MEDIA’ to clearly include such images as business cards, posters, leaflets and other still advertising images. This along with a statement of the intended use of the taxonomy has been changed (Figure 7.2).
Table 7.2 summarises all areas of concern raised during round 3 of discussions, related to the taxonomy. All responses/actions taken in response to these issues are included in Appendix 5.1 in detail.

<table>
<thead>
<tr>
<th>Areas of concern</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All advertising media in the form of still images should be included in the taxonomy</td>
<td>Explained in the detail discussions area</td>
</tr>
</tbody>
</table>
| 2. Appropriateness and comprehension of Version 2 of the taxonomy               | 75% - Yes  
25% - Yes (considering it is a work in progress) |
| 5. Does the taxonomy as a research tool offer interrater reliability?           | Explained in the detail discussions area                                   |

Table 7.2 Areas of concerns & responses

**General comments from round 3 on the revised version of the taxonomy**
- All participants agreed that the revised version of the taxonomy is a comprehensive and appropriate research tool for research in an educational context with regards to the types of images and the graphicacy skills (the ability to communicate [code & decode] information through still visual images) required to deal with them.
### A Taxonomy of Graphicacy

**(version 3)**

*The taxonomy was designed for use in research of still image use within an educational context*

<table>
<thead>
<tr>
<th>PICTORIAL: WESTERN ART</th>
<th>Category description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIFE DRAWING</td>
<td>Representations from an individual artistic perspective.</td>
</tr>
<tr>
<td>LANDSCAPE</td>
<td>Usually the item produced is a finished product itself.</td>
</tr>
<tr>
<td>STILL LIFE</td>
<td>To be decoded, the observer needs to interpret these images within the artists’ cultural, educational or professional context.</td>
</tr>
<tr>
<td>PORTRAITS</td>
<td></td>
</tr>
<tr>
<td>OTHER COMPOSITIONS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PICTORIAL: DRAWING</th>
<th>Category description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAFTS</td>
<td>Products finished to an appropriate level of accuracy to closely mirror an idea/observation.</td>
</tr>
<tr>
<td>SKETCHING</td>
<td>This is often a means to achieve/get to the next stage.</td>
</tr>
<tr>
<td>DRAWING</td>
<td>To be decoded the observer needs to identify the idea/observation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PICTORIAL: DIAGRAMS</th>
<th>Category description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSPECTIVE</td>
<td>Technical diagrams to define clearly features, details and/or requirements such as relationships, processes, components.</td>
</tr>
<tr>
<td>ARCHITECTURAL</td>
<td>To be decoded, the observer has to have developed the relevant spatial abilities and understanding of the technique.</td>
</tr>
<tr>
<td>ENGINEERING/TECHNICAL</td>
<td></td>
</tr>
<tr>
<td>EXPLODED</td>
<td></td>
</tr>
<tr>
<td>PROJECTIONS</td>
<td></td>
</tr>
</tbody>
</table>
Chapter Seven: Results

Figure 7.2 The Taxonomy FINAL VERSION (for this thesis; Version 3)

- Images which illustrate the sequence of a thought, process or story.
- Information follows a relative sense of direction.
- To be decoded, the observer needs to be able to identify the flow of information.

- Symbolic representation of data, information and/or warnings.
- To be decoded the observer must recognise and make connections between the data and/or information represented.

- Representations of a message, a person, a scene or an area.
- To be decoded the observer must recognise and make connections between the messages represented.

- Relating to photographs, especially representing or simulating something with great accuracy and fidelity of detail.
- To be decoded the requirements might include any of the above, but the capabilities required to create them depends on the hardware and software used.

- 2-dimensional and 3-dimensional images created with the use of computer software.
- To be decoded the requirements might include any of the above, but the capabilities required to create them depends on the software package.

- Other miscellaneous still visual images.
7.1.2 Pilot study 1: Cyprus school results

Conducting the pilot in a Cypriot school

In Cyprus, research is not considered to be something common. Most teachers from the school involved with the study initially considered research as an alien, to them, action. For this reason, on the first day of the pilot study, teachers felt intimidated talking to a researcher or being interviewed.

Thirteen teachers each from a different subject area were interviewed during this study. These included the following subject areas: Greek Language, foreign languages, mathematics, biology, chemistry, physics, religious studies, music, art, design and technology, food technology, geography, history and ICT.

All teachers signed a consent form following the ethical guidelines required during interviews (Annex 7). The formality of the form and the fact that the teachers had to place their name on the form and sign it seemed frightening to most of them. None of the teachers except Mrs Stephanou accepted having the interview audio recorded, for fear of having information somehow used against them in the future. This was so, even though it was clearly explained to the teachers that all information would be used anonymously and confidentially by the researcher, and all data gathered would be destroyed in three to five years after the completion of the research degree.

By lunchtime on the first day, all the stress and suspicion had completely vanished amongst all teachers. This allowed for smoother and more comfortable interviews to be conducted.

The results from the pilot study were brought together in a number of comparison graphs along with the results gathered later from case studies 1 (conducted in a school in Boston) and 2 (conducted in a school in the UK). This was due to the good quality of the results gathered during the pilot study as well as the effectiveness of the methodology used. A lot was learnt about applying the methodology in the pilot study; it was not necessary to change it for case studies 1 and 2.

7.1.3 Case study 1: USA school results

Conducting the pilot in a USA school

In this particular school in the USA teachers were very familiar and comfortable with the concept of research. Teachers had no concerns when signing the same consent form provided during pilot study 1. All teachers agreed in having the interview audio recorded (Annex 8). Eight teachers each from a different subject area were interviewed during this study. These included the following subject areas: calculus, algebra, foreign languages,
biology, chemistry, art, history and ICT Java. When considering the number of interviewees appropriate for this case study, advice taken from Kvale (1996:101) was taken into consideration; ‘one conducts interviews with as many people as necessary in order to gain the information sought’. Even though it was not possible to interview the same number of teachers as interviewed in Cyprus, enough information was gathered to allow a satisfactory study primarily based on answering the key questions of this initial study (is graphicacy used across the curriculum?).

7.1.4 Case study 3: UK school results

Conducting the pilot in a UK school

Case study 3 did not include any interviews on the use of images (refer to section 6.2.5 for methodology). It was based only on the analysis of textbooks. The subject areas looked at for this study included: mathematics, science, DT, English Language, French, geography and RE. The selection of the subject areas was opportunistic, as the researcher was not involved in gathering any textbooks. These were gathered by Mr Macfrici, the Head of the Design and Technology of the school who acted as a champion for this study. The methodology used for the analysis of textbooks in this study was the same as the methodology used in pilot study 1 and case study 1.

7.1.5 Overall results

The use of graphicacy across the curriculum

Figure 7.3 illustrates the most popular graphicacy elements across the three schools shown with the individual results summated. After analysing the results gathered from the Cypriot and USA school, the element of graphicacy labelled as ‘annotated’ was removed from the taxonomy. This was due to the fact that it did not offer sufficient unique characteristics with regards to learning how to read and understand an annotated diagram, or creating it. Any type of image could be annotated, incorporating literacy and graphicacy. This was considered to be a secondary action. The primary action would be the creation of the image, which could include any element of graphicacy. For this reason there were no results from the UK school on the use of annotated images. This is illustrated by a question mark placed in the graph below in the relevant area.
Photographs are the most popular graphicacy element used across the 3 schools followed by charts and graphs, both from the symbolic category according to Version 1 of the taxonomy. According to the latest version, the most commonly used graphicacy element falls under the photographic category. The next most popular category is within the sequential category; story boards. Next are drawings within the pictorial category. All the other categories are used in less than half the lessons included in this study.
Figure 7.4 illustrates the popularity of each graphicacy element per school, illustrated in 3 separate graphs; one for each school. This enables a clear view of the most and least popular elements of graphicacy to be observed according to each school. The same results have been listed in Table 7.3 and Figure 7.5 to allow for a more comprehensive comparison.
Table 7.3 lists the percentage of graphicacy elements use found in the textbooks analysed across the subject areas studied within the 3 schools. These are listed in a hierarchical order.

<table>
<thead>
<tr>
<th></th>
<th>Cyprus</th>
<th>USA</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>75%&gt;</td>
<td>photographs; symbols, charts &amp; graphs; story boards, spider diagram.</td>
<td>photographs.</td>
<td>photographs, advertisements, maps; symbols, charts &amp; graphs; drawings, spider diagrams, storyboards.</td>
</tr>
<tr>
<td>75%&lt;50%&gt;</td>
<td>drawings; annotated, perspective/projections, maps; flow diagrams; art.</td>
<td>drawing; perspective/projections, diagrams annotated; charts &amp; graphs, maps; story boards, spider.</td>
<td>engineering/technical flow diagrams other;</td>
</tr>
<tr>
<td>50%&lt;25%&gt;</td>
<td>other; CAD, 3D; Landscape, engineering/technical;</td>
<td>engineering/technical, flow diagrams, symbols, 3D; art, sketching, advertisement, other;</td>
<td>perspective/projections, CAD, sketching; art, still life, exploded,3D;</td>
</tr>
<tr>
<td>25%&lt;</td>
<td>sketching, architectural, exploded; cartoons; advertising; life drawings, portraits, still life;</td>
<td>architectural, CAD; cartoons;</td>
<td>life drawing, portraits, drafts, architectural, cartoons;</td>
</tr>
<tr>
<td>0%</td>
<td>drafts.</td>
<td>life drawing, landscape, portraits, still life, drafts, exploded.</td>
<td>landscape.</td>
</tr>
</tbody>
</table>

The element of ‘drafts’ within the pictorial category only featured in a textbook of one lesson from the UK school. Other areas such as portraits, still and life drawing were also uncommon amongst a large number of subject areas with less than 10% of them featuring in their textbooks.

Figure 7.5 illustrates the pattern created based on the popularity of image use across the 3 schools. The three different types of lines are drawn for easier pattern recognition, having colour co-ordinated bars relating to each type of image (graphicacy element). The results on the x axis are placed according to each graphicacy element; starting on the left hand side with the Cypriot school results, following to the USA and the UK results. All results have been
normalised out of 10 for fair comparison. The results suggest a great similarity in the pattern of the image use (Figure 7.5).

The UK school uses the most graphicacy elements in relation to the three schools, with an average of 13 types (value has been rounded off to the nearest decimal number) of elements across the subjects studied. The Cypriot school follows with an average of 12 and then the USA school with an average of 9.

The number of average graphicacy elements used across the subject areas was calculated by counting the different graphicacy elements used across all the subject areas studied within each school, and dividing by the number of the relevant subject areas.
Figure 7.5 Comparative graph of graphicacy use
• In School B (from the USA) the category of graphic arts (within the pictorial category) is not greatly used. For example, life drawing, landscape, portraits, still life, and drafts are not used in the textbooks of the subjects surveyed in the USA school;

• Within all 3 schools, the least used area of graphicacy is the graphic arts;

Most elements of the taxonomy are used across the curriculum.

Figure 7.6 illustrates the popularity of types of images in Cyprus (School A), USA (School B) and UK (School C). In the UK, the school uses a total of 51% (rounded at the nearest decimal number) of the possible image types within the subjects that were surveyed. In Cyprus, 45% was used, and in the USA 39%. In one of the teacher interviews in the USA school, a teacher suggested that using images in books was related to lower ability children.

The school in Cyprus has the highest percentage of graphic arts image use. Teachers' opinions about the use of images and/ or drawings varied. A Religious Education (RE) teacher had a genuine enthusiasm about images and drawings and used in-depth analysis of techniques used to paint the original pieces discussed, which was clearly influencing her lessons and the students' outcomes. Their exercise books had many drawings and illustrations as part of the students' answers/ homework. A history teacher shared a completely different view; she stated that 12-and 13-year old students do not have the capacity to understand maps, so she put no emphasis on them during the lesson, even though maps often appeared in the textbooks used for the lesson. The school in the USA had a small percentage of graphic art media used in lessons. While talking to the art teacher, it was clear the subject area was seen, by the staff and most students, as the time for the students to relax before they went back to the "important and serious" lessons.

In most cases the school in the USA uses fewer images than the other two schools, apart from drawings. The UK school showed very high percentages of image use for diagrams, sequential and symbolic types but uses the least amount of computerised images across the curriculum.
Figure 7.6 Percentage of image use per school/country

Figure 7.7 illustrates the subjects areas analysed and the types of images they used. It indicates the popularity of the different type of images. All subject areas analysed during the study were plotted against the number of types of images from each area the taxonomy. The colour-coordinated bars illustrate the frequency of the types of images used per subject. This revealed that most subject areas use images from all four main categories of the taxonomy.
However,

- No sequential images were found to be used within the Cypriot textbooks for physics in Cyprus, history in the USA, and English language in the UK.
- One of the subject areas with the most limited variations of images used was found to be art in Cyprus and USA. The lessons seemed to be mainly focused on the pictorial type of images.

Figure 7.8 illustrates the amount of variety of images used by each subject area according to UK, Cyprus and the USA. These results were placed in a hierarchical order in Table 7.4. Design and technology used the biggest variety of images in teaching, both in Cyprus and the UK (22/25 and 18/25 equivalent), whereas in the USA the biggest variety of image use was found to be in calculus (14/25).
Figure 7.8 Graphicacy use by each subject area

<table>
<thead>
<tr>
<th>Subject areas in USA, Cyprus and UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY</td>
</tr>
<tr>
<td>18/25 : DT</td>
</tr>
<tr>
<td>14/25: biology, languages, RE</td>
</tr>
<tr>
<td>4/25: art</td>
</tr>
</tbody>
</table>
Graphicity across the curriculum

The results focused on cross-curricular links concerning inbound (reading and understanding/decoding) graphicity skills gathered from this study are illustrated in a table form in Tale 7.5. The table illustrates the cross-curricular links between subject areas within each school, as well as a general outcome within all schools for each individual element of graphicity.
<table>
<thead>
<tr>
<th>Graphicacy elements</th>
<th>UK school</th>
<th>Cyprus school</th>
<th>USA school</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maths</td>
<td>Science</td>
<td>DT</td>
</tr>
<tr>
<td>Art</td>
<td>x</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>Life drawing</td>
<td>x</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Landscape</td>
<td>0</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Portraits</td>
<td>x</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Still life</td>
<td>x</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>Drafts</td>
<td>x</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Sketching</td>
<td>x</td>
<td>x</td>
<td>3</td>
</tr>
<tr>
<td>Drawing</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Architectural</td>
<td></td>
<td>x</td>
<td>1</td>
</tr>
<tr>
<td>Engineering-technical</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Explored</td>
<td>x</td>
<td>x</td>
<td>4</td>
</tr>
<tr>
<td>Perspective</td>
<td>x</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Projections</td>
<td>x</td>
<td>x</td>
<td>3</td>
</tr>
<tr>
<td>Cartoons</td>
<td>x</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Story board</td>
<td>x</td>
<td>x</td>
<td>4</td>
</tr>
<tr>
<td>Flow diagram</td>
<td>x</td>
<td>x</td>
<td>7</td>
</tr>
<tr>
<td>Spider diagram</td>
<td>x</td>
<td>x</td>
<td>6</td>
</tr>
<tr>
<td>Charts &amp; graphs</td>
<td>x</td>
<td>x</td>
<td>6</td>
</tr>
<tr>
<td>Symbols</td>
<td>x</td>
<td>x</td>
<td>7</td>
</tr>
<tr>
<td>Maps</td>
<td>x</td>
<td>x</td>
<td>7</td>
</tr>
<tr>
<td>Photographs</td>
<td>x</td>
<td>x</td>
<td>7</td>
</tr>
<tr>
<td>Advertisements</td>
<td>x</td>
<td>x</td>
<td>7</td>
</tr>
<tr>
<td>CAD</td>
<td>x</td>
<td>x</td>
<td>3</td>
</tr>
<tr>
<td>3D</td>
<td>x</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>x</td>
<td>x</td>
<td>4</td>
</tr>
</tbody>
</table>

Out of 25 elements: 14, 19, 21, 8, 9, 11, 10, 11, 13, 12, 12, 19, 5, 15, 10, 11, 12, 8, 10, 12, 14, 8, 7, 10, 13, 7, 11, 2

Table 7.5 Cross-curricular links concerning inbound graphicacy skills
The links between subject areas within the UK school are listed in Table 7.6. Under the section of ‘Cypriot school’ the subject areas of English, French and German languages are listed as one under the title of ‘languages’. In the same way French and German languages from the USA school are referred to as ‘languages’. The percentage of subject areas using each element, amongst the subject areas researched, are also shown. Where the percentage is not 0% but there is still no cross-curricular link, it implies that only one subject area was found to use that element.

<table>
<thead>
<tr>
<th><strong>Common graphicacy elements</strong></th>
<th><strong>% of cross-curriculum use</strong></th>
<th><strong>UK school (7 subject areas)</strong></th>
<th><strong>% of cross-curriculum use</strong></th>
<th><strong>Cypriot school (13 subject areas)</strong></th>
<th><strong>% of cross-curriculum use</strong></th>
<th><strong>USA school (8 subject areas)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Art</td>
<td>28.6%</td>
<td>Maths – DT</td>
<td>53.8%</td>
<td>Physics – DT – art – Greek l. – history – music – RE</td>
<td>37.5%</td>
<td>French/ German I. – history - art</td>
</tr>
<tr>
<td>Life drawing</td>
<td>14.3%</td>
<td>N/A</td>
<td>15.4%</td>
<td>Languages – RE</td>
<td>0%</td>
<td>N/A</td>
</tr>
<tr>
<td>Landscape</td>
<td>0%</td>
<td>N/A</td>
<td>30.8%</td>
<td>Art – geography – ICT – RE</td>
<td>0%</td>
<td>N/A</td>
</tr>
<tr>
<td>Portraits</td>
<td>14.3%</td>
<td>N/A</td>
<td>7.7%</td>
<td>N/A</td>
<td>0%</td>
<td>N/A</td>
</tr>
<tr>
<td>Still life</td>
<td>28.6%</td>
<td>Science – DT</td>
<td>7.7%</td>
<td>N/A</td>
<td>0%</td>
<td>N/A</td>
</tr>
<tr>
<td>Drafts</td>
<td>14.3%</td>
<td>N/A</td>
<td>7.7%</td>
<td>N/A</td>
<td>0%</td>
<td>N/A</td>
</tr>
<tr>
<td>Sketching</td>
<td>42.9%</td>
<td>Maths - science – DT</td>
<td>23.1%</td>
<td>Physics – DT – languages</td>
<td>37.5%</td>
<td>Calculus – languages - art</td>
</tr>
<tr>
<td>Architectural</td>
<td>14.3%</td>
<td>N/A</td>
<td>23.1%</td>
<td>history – music – RE</td>
<td>25%</td>
<td>Calculus – geography</td>
</tr>
<tr>
<td>Exploded</td>
<td>28.6%</td>
<td>science -DT</td>
<td>7.7%</td>
<td>N/A</td>
<td>0%</td>
<td>N/A</td>
</tr>
<tr>
<td>Perspective</td>
<td>42.9%</td>
<td>science – DT – French l.</td>
<td>53.8%</td>
<td>Maths – physics – DT- languages – geography – history – RE</td>
<td>25%</td>
<td>Calculus – languages</td>
</tr>
<tr>
<td></td>
<td>Projections</td>
<td>Cartoons</td>
<td>Storyboards</td>
<td>Flow diagrams</td>
<td>Spider diagrams</td>
<td>Charts &amp; graphs</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
<td>----------</td>
<td>-------------</td>
<td>--------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td>71.4%</td>
<td>14.3%</td>
<td>100%</td>
<td>57.1%</td>
<td>85.7%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Maths - science - DT-geography – RE</td>
<td>N/A</td>
<td>Maths - science - DT-English l. – French l. - geography – RE</td>
<td>Maths - science - DT-geography</td>
<td>84.6%</td>
<td>Maths - science - DT-English l. – French l. - geography – RE</td>
</tr>
<tr>
<td></td>
<td>61.5%</td>
<td>30.8%</td>
<td>84.6%</td>
<td>69.2%</td>
<td>84.6%</td>
<td>92.3%</td>
</tr>
<tr>
<td></td>
<td>75%</td>
<td>12.5%</td>
<td>75%</td>
<td>50%</td>
<td>62.5%</td>
<td>75%</td>
</tr>
</tbody>
</table>
### Table 7.6 Cross-curricular links of graphiyacy elements

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advertisements</strong></td>
<td>85.7% Maths - Science - DT - English I. - French I. - Geography - RE</td>
<td>15.4% DT - Languages</td>
<td>37.5% Calculus - Languages - History</td>
</tr>
<tr>
<td><strong>CAD</strong></td>
<td>42.9% Science - DT - Geography</td>
<td>46.2% Biology - Chemistry - Physics - DT - Greek I. - ICT</td>
<td>25% Biology - Chemistry</td>
</tr>
<tr>
<td><strong>3D</strong></td>
<td>28.6% Science - DT</td>
<td>38.5% Biology - Chemistry - Physics - DT - Geography</td>
<td>37.5% Calculus - Geography - Chemistry</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>57.1% Maths - Science - French I. - RE</td>
<td>46.2% Biology - Chemistry - DT - Languages - Greek I. - History</td>
<td>37.5% Chemistry - Languages - ICT</td>
</tr>
</tbody>
</table>

**Patterns of graphiyacy use**

Images per subject area were placed in the taxonomy and were clustered into subject areas. Patterns were noted that stemmed from repeated themes (Appendix 5.1). A detailed analysis of the teaching purpose of each type of image gathered was noted. Twelve main teaching purposes of the use of images emerged for the data analysed across all schools.
From the pictorial, sequential, symbolic, and CAD categories of the taxonomy, the following teaching purposes emerged for the use of such images:

- Gain familiarity and place new knowledge into context;
- support embedding new knowledge;
- provoke interest;
- spark conversation;
- illustrate students’ ideas, knowledge, and understanding;
- visual stimulation;
- visual representation of information/data;
- test students’ knowledge;
- test students’ understanding; and
- explore research, and understanding.

From the additional category which emerged from the pilot study entitled “Other”, the following two teaching purposes emerged for the use of such images:

- Organize information; and
- learn through play.

**Effectiveness of the methodology**

Delphi study round 2 of discussions provided feedback based on the participants’ opinion on the methodology adopted during the studies on graphicacy across the curriculum. The approach of the 25+ categories within the taxonomy was found to be ‘very informative’. All participants agreed that breaking the taxonomy into 25 types of images was the appropriate method for a research tool to be used in the cross-curricular textbooks analysis. Feedback included comments such as: ‘having a broad range of types makes it possible to reflect the complexity and specificity of the curriculum’. Depending on the research focus the taxonomy is used for, each category (element of graphicacy) can be subdivided to provide greater levels of specificity.
7.2 Continuity and progression descriptors

7.2.1 Pilot study 2: workshop results

The pilot study provided strong evidence towards a useful strategy for this research. The work conducted with the group of students and the analysis of their work brought to light further detailed requirements on continuity and progression (CaP) descriptor which resulted in more detailed descriptors lists for rendering, perspective drawing and logo design. These lists were developed while assessing students’ work.

Rendering

Figure 7.9 illustrates the rate of success each student had on every task completed on rendering. It is clear that students performed best during the class exercise while working along with the adults, as that is the task all students completed with the most success. From the results of this pilot study, there are some indications of progression in the students’ skills and understanding of rendering. This is shown by the number of students who showed improvement (11/24). A small number scored less in the last task (4/24) and some showed no difference (9/24). Seven students did not manage to score any points for the first task, and four of those students showed improvement by 10% - 20% in the last task. The scores of the rate of success of the students have been normalised out of 100 to give a fair comparison and the tasks are labelled according to the labelling system used on the students’ worksheet booklet.
During the analysis of the students’ work the CaP descriptors were refined, and a more detailed list of descriptors emerged. A sample of the analysis for one student is show in Table 7.7.

<table>
<thead>
<tr>
<th>Rendering CaP descriptors</th>
<th>Students’ work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasks</td>
<td>1a</td>
</tr>
<tr>
<td>Identify a light source</td>
<td></td>
</tr>
<tr>
<td>Rendering</td>
<td></td>
</tr>
<tr>
<td>All visible surfaces coloured in using the correct tone</td>
<td></td>
</tr>
<tr>
<td>All visible surfaces coloured in using the correct gradient</td>
<td></td>
</tr>
<tr>
<td>Gradient of colour applied in a smooth form where appropriate</td>
<td></td>
</tr>
<tr>
<td>Shading to suggest the correct form/ shape of the object</td>
<td></td>
</tr>
<tr>
<td>Shading drawn to suggest a specific finish i.e. wood, matt, shiny</td>
<td>n/a</td>
</tr>
<tr>
<td>Shadow</td>
<td></td>
</tr>
<tr>
<td>Shadow added</td>
<td></td>
</tr>
<tr>
<td>Shadow added at the correct direction</td>
<td></td>
</tr>
<tr>
<td>Shadow coloured in using a gradient</td>
<td></td>
</tr>
<tr>
<td>Shadow coloured in using the correct gradient</td>
<td></td>
</tr>
<tr>
<td>Shadow added to suggest the correct form of the shape</td>
<td></td>
</tr>
<tr>
<td>Shadow added correctly according to the distance of the light source</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.7 Rendering: students’ work analysis
Figure 7.10 indicates the success rate of the students according to the CaP descriptors. As an initial stage the descriptors were placed in an assumed level of difficulty. This was later largely validated by the rate of success each task had. The most commonly completed descriptors tend to be within the first and most fundamental skills one gains while learning how to render correctly such as identifying the light source and using the correct colour tone on each visible surface of a shape. According to the results, colouring-in the shadow using a gradient is the most difficult of the tasks described here along with adding the shadow correctly according to the distance of the light source.

---

Figure 7.10 Rendering: rate of successfully completed per level descriptor
## Rendering list descriptors

<table>
<thead>
<tr>
<th>Successful examples</th>
<th>Unsuccessful examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Successful example" /></td>
<td><img src="image2" alt="Unsuccessful example" /></td>
</tr>
<tr>
<td>Identify a light source</td>
<td></td>
</tr>
</tbody>
</table>

### Rendering

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Successful example" /></td>
<td><img src="image4" alt="Unsuccessful example" /></td>
</tr>
<tr>
<td>All visible surfaces coloured-in</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Successful example" /></td>
<td><img src="image6" alt="Unsuccessful example" /></td>
</tr>
<tr>
<td>All visible surfaces coloured-in applying a gradient</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7" alt="Successful example" /></td>
<td><img src="image8" alt="Unsuccessful example" /></td>
</tr>
<tr>
<td>All visible surfaces coloured-in using the correct (lighter colour near the light source, darker colour as it gets further away) gradient</td>
<td></td>
</tr>
</tbody>
</table>
Gradient of colour applied correctly, in a smooth form where appropriate

Shading the object to suggest the correct form/shape
(Cylinder: shading to follow a long vertical lines running across the length of the form. Cone: shading to follow triangular shaped or long lines from the tip to the base. Sphere: shading to follow circular diameters. Cube: shading blending uniformly for a matt finish)

Shading drawn to suggest metallic finish by creating clearly/distinctly/sharply different areas of light, ranging from white/un-shaded to black/dark

Shading drawn to suggest wooden finish by drawing wood grains in the appropriate directions (lines connecting on at least 2 edges for cuboids)
Shading drawn to suggest matt finish by blending the edges of the different areas of lights

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shadow added</td>
<td></td>
</tr>
<tr>
<td>Shadow added in the correct direction</td>
<td></td>
</tr>
<tr>
<td>Shadow added to suggest the correct form of the shape</td>
<td></td>
</tr>
</tbody>
</table>
Shadow added correctly (Drawing 2 lines passing through each corner of the box. One extends from the light source, the other is either parallel lines or from a vanishing point if using perspective. Where lines from the same vertical plane (of the object) intersect, is the point the shadow will reach) according to the distance of the light source, suggesting the correct form of the shape.

Figure 7.11 Refined final descriptors for rendering; drawn after further reflection subsequent to analysis.

### Delphi group discussions: Validating the results on rendering

Table 7.8 lists the areas of concern and responses received on the methodology and results gathered from the study focused on rendering. These issues are described in further detail in Appendix 5.2

<table>
<thead>
<tr>
<th>Areas of concern</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is the methodology presented for gathering data within practice appropriate?</td>
<td>100% - Yes</td>
</tr>
<tr>
<td>2. Could this research strategy develop an understanding of progression in rendering?</td>
<td>100% - Yes</td>
</tr>
<tr>
<td>5. Do you think the descriptors generated would be useful during assessment for learning relating to rendering?</td>
<td>67 % - Yes, 33 % - No, because it isn’t assessment for learning</td>
</tr>
<tr>
<td>6. Would you add, remove or change the order of any of final list of descriptors?</td>
<td>33 % - Yes, 67 % - No</td>
</tr>
<tr>
<td>7. ‘Shadow added to suggest the correct form of the shape’ seems to be more difficult that ‘shadow added correctly according to the distance of the light source’</td>
<td>Explained in the detail discussions area. Additionally, it has been added in the discussion of round 4 for further discussion.</td>
</tr>
</tbody>
</table>

Table 7.8 Summary of Delphi study group discussion round 3
One responder stated that ‘the generated descriptors seem extremely useful for the assessment of learning relating to rendering. The same descriptors can guide as well teaching interventions for further in-depth studying of rendering’. Another view puts emphasis on how these descriptors could be used to assess different renderings done by different students in different media’. The list of descriptors provided has been described as ‘very interesting’ and one participant stated that ‘it works for the task being studied. It is important to clarify that the list is not exhaustive and merely provides an example of a method to collect such descriptors and initial set of results. Further work has to be completed if it is to include aspects such as different media, shapes, multiple or coloured light sources etc. The order of 2 items on the descriptors list has been challenged according to the level of difficulty (point number 7 in Table 7.8). The use of illustrations to support assessment decisions in a visual subject has been described as ‘effective and should be explored further’. 

**Logo design (symbolic representations)**

Figure 7.12 shows a decrease (approximately 2.75%) of the overall skills and abilities between the two tasks on symbolic representations. This is due to the fact that for ‘task H’ students placed more emphasis on creating different fonts in a graffiti art style whereas after the lesson they based their designs mainly on symbolic representations to create the logos. Figure 7.13 breaks down the level of progression between the two tasks relating it to specific areas analysed. Points are awarded per successfully completed CaP descriptor and the results are reported for all the students’ scores together. Between tasks H and I, there was an increase from 1 to 11 respectively out of the possible 120 points for correct use of colour (5 CaP descriptors relating to colour for 24 students: 5x24=120). In regards to symbolic representations there was an increase from 58 to 78 out of the possible 120. However, since students placed heavy emphasis on graphic representations the first time, there seemed to be a decrease in score when dealing with text (font) from 68 points scored in Task H to 33 scored in Task I out of the possible 96 points (4 CaP descriptors times the 24 students). These results are illustrated in Figure 7.13. The scores have been normalised out of 100 to give a fair comparison.

The tasks were analysed based on the list of level descriptors which were refined and developed during the analysis of the students’ work. An example of analysis for one student’s work is shown in Table 7.9.
Figure 7.12 Symbolic representations: Students’ rate of success per task

Figure 7.14 Symbolic representations: Students’ rate of success per area of analysis

<table>
<thead>
<tr>
<th>Symbolic representations CaP descriptors</th>
<th>Students’ work</th>
<th>Student 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tasks</strong></td>
<td>1h</td>
<td>1i</td>
</tr>
<tr>
<td>Colour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used colours</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Use the correct colour to represent the company correctly</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Use of appropriate colours to relate to the intended customers</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Use the correct colours to communicate specific emotions</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Use simple colour combinations to send out a message</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Font</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used text</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>
Table 7.9 Symbolic representations: students’ work analysis

Most students were able to use graphic representation to portray a specific idea and theme but the short lesson did not prove enough to encourage students to use colours to represent emotions or other ideas. Figures 7.14 and 7.15 illustrate the rate of success between the three areas of analysis.

Figure 7.14 Symbolic representations: rate of successfully completed CaP descriptors during task H and I combined

Due to the reasons explained above, the apparent results of students’ progress between the two tasks are misleading. Seven out of 24 seemed to have completed the second task with more success, 7 made no progress and 10 appear to have performed worse. If we take into consideration the fact that the students have proven their skills when dealing with fonts (text)
and add the number of new skills demonstrated in the second task, we see an increase in 18 out 24 students' achievements (Figure 7.15).

The results drawn from the workshop session were inadequate for thorough analysis towards continuity and progression descriptors for logo designing. The descriptors drawn for the analysis of the students' work were considered too vague and general to be regarded as the 'final CaP descriptors list' for logo design. The results were, however, presented at the international Design And Technology Association conference in 2010. Experienced secondary schools teachers, academics and researchers discussed the results, and suggested additional descriptors as well as propositions for breaking some of the existing descriptors into numerous detailed stages. Figure 7.16 illustrates the continuity and progression descriptors for logo design drawn after thorough consideration of the data gathered. Unlike the previous CaP descriptor lists presented so far, Figure 7.16 does not include illustrations taken from students' work for each descriptor, because the study did not provide suitable examples. Instead, were relevant, images are placed often taken from the internet, or lists with examples are provided to give an understanding of the descriptors.
**Colours**

<table>
<thead>
<tr>
<th>Use/ selection of colours</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fashion: pink, blue-green, turquoise, royal blue, silver.</td>
</tr>
<tr>
<td>• Trade industries: medium blue, royal blue, white, green, orange.</td>
</tr>
<tr>
<td>• Healthcare: dark blue, light blue, green, white, turquoise.</td>
</tr>
</tbody>
</table>

- Business: black on white board, dark blue, dark red, dark green, white.

**Use the correct colour to represent the company**
Some common examples of colour use to represent companies are illustrated above

- White - great for wedding supplies in the United States or Canada;
- White - symbolizes death in eastern countries;
- Purple - often attract young children;
- Black - attracts teens due to the mystery behind it;
- Deep green - preferred by the wealthy;
- Blue - a universally accepted business colour because it indicates loyalty, integrity, and trustworthiness;
- Pink - often appealing to women;
- Blue - more appealing to men.

**Use of appropriate colours to relate to the intended customers**
Some common examples of colour use to relate to the intended customers are listed above

- White - purity, neutrality, sterility and youth;
- Black – empowerment, intimidation, mystery;
- Deep green - preferred by the wealthy;
- Blue – cleanliness, loyalty, integrity, trustworthiness;
- Pink – inspiring, tranquilizing, reflects innocence;
- Red – pressure, fear, danger, money;
- Orange – adventures, energy, enthusiasm, balance;
- Green – relaxing, nature;

**Use the correct colours to communicate specific emotions**
Some common examples of colour used to communicate specific emotions are listed above
- Harmonizing colours: blue, light blue, and cyan or perhaps red, orange, and yellow.
- Contrasting colours: Red, green and blue. Shades of purple with shades of green.
- Complementary colours: Blue with yellow. Green, purple and magenta. They can work by separating them on the page with other colours.

Use simple colour combinations to send out a message.
Some common examples of colour combinations are listed above.

### Font

<table>
<thead>
<tr>
<th>Font Style</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Serif</strong></td>
<td>Connotes stability, timelessness, classicism, elegance and a sense of history. Probable best known serif font is ‘Times Roman’. Be warned when considering the use of a serif font is that the serif fonts are designed for print and they do lose some of their subtleties when used in Web pages.</td>
</tr>
<tr>
<td><strong>Sans serif</strong></td>
<td>Suggests a contemporary, innovative more forward-thinking brand. Arial is a good example of this type of font. As they are cleaner in their design than serif fonts they are good to use even at a small size. Often found used on perfume bottles or for wedding companies.</td>
</tr>
<tr>
<td><strong>Decorative</strong></td>
<td>Fun and attractive. You can find them on products for children, entertainment companies etc.</td>
</tr>
</tbody>
</table>

Use the correct font to communicate a specific feeling.
Some common examples of font use to convey a feeling are given above.
### Graphic representations

- Work well in black, reversed out and in full colour;
- Work well in various size;
- Adaptable: work both horizontally and vertically;
- Readability for various text sizes.

**Use appropriate graphic representations for it to be functional**

Some common features a logo should have are given above as examples.

- A logo for children’s toys store would be appropriate to use a font and colour scheme appealing to children. This would not be so appropriate for a law firm.

**Use appropriate images to relate with the given theme**

An example is provided above.

- If you are an artist or a state-of-the-art computer company, you may want a logo that is more abstract and contemporary. Shapes and symbols are good choices for an abstract look. Even using black and white as colours on a unique design gives a contemporary look and feel.

**Use appropriate graphic representations to relate to the intended customers**

Examples are provided above.

- No longer selling just books, they wanted a new logo that would represent them selling almost everything. The elegant answer being a joining line that not only looks like a smile, but connects the A and the Z, as in “Sell everything from A to Z.”

**Create original ideas to convey a message**

Examples are provided above.

- Combining illustrations which accurately represent part of the company's name while using symbolic representations to illustrate the other half.

**Create innovative/smart/successful/ eye catchy ideas to convey a message**

Some attribute to achieve that are listed above.

---

Figure 7.16 Continuity and Progression descriptors for logo design
Perspective

The group was taught two-point perspective for the first time so the first task was designed to identify the initial level of 3 dimensional drawing abilities. The descriptors were once again placed in an assumed order of difficulty. Figure 7.17 indicates the level of success amongst the tasks. Drawing basic cube shapes freehand is one of the first and easiest tasks whereas the descriptors from the last and more challenging tasks clearly have the least number of successes.

![Perspective drawing CaP descriptors](image)

Figure 7.17 Perspective: rate of successfully completed level descriptors

Table 7.10 shows a sample of the analysis of one students’ work against the CaP descriptors for perspective drawing. The results from all students’ work are displayed in Figure 7.19.

<table>
<thead>
<tr>
<th>Two point perspective CaP descriptors</th>
<th>Students’ work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Student 1</td>
</tr>
<tr>
<td>Tasks</td>
<td>1d</td>
</tr>
<tr>
<td>3d cube</td>
<td></td>
</tr>
<tr>
<td>Draw freehand a 3 dimensional cube</td>
<td>/</td>
</tr>
<tr>
<td>Correctly draw freehand 3 dimensional cube</td>
<td>/</td>
</tr>
<tr>
<td>Draw freehand a correct and accurate cube</td>
<td>/</td>
</tr>
<tr>
<td>Basic technique</td>
<td></td>
</tr>
<tr>
<td>Identify a horizon</td>
<td>n/a</td>
</tr>
<tr>
<td>Identify the vanishing point</td>
<td>n/a</td>
</tr>
<tr>
<td>Correct use of vertical lines drawn</td>
<td>n/a</td>
</tr>
<tr>
<td>Correct use of diagonal lines drawn</td>
<td>n/a</td>
</tr>
<tr>
<td>Correct use of diagonal lines drawn</td>
<td>n/a</td>
</tr>
<tr>
<td>Drawing a cube correctly on, above</td>
<td>n/a</td>
</tr>
<tr>
<td>and below eye level</td>
<td></td>
</tr>
<tr>
<td>Modifying the main shape form</td>
<td></td>
</tr>
<tr>
<td>Draw a cube in 2p.p. and remove a</td>
<td>n/a</td>
</tr>
<tr>
<td>smaller cube from the left hand</td>
<td></td>
</tr>
<tr>
<td>corner of the main shape</td>
<td></td>
</tr>
<tr>
<td>Draw a cube with a piece cut out in</td>
<td>n/a</td>
</tr>
<tr>
<td>the front left hand corner</td>
<td></td>
</tr>
<tr>
<td>Draw the above cube (with a piece</td>
<td>n/a</td>
</tr>
<tr>
<td>cut out in the front left hand</td>
<td></td>
</tr>
<tr>
<td>corner.</td>
<td></td>
</tr>
</tbody>
</table>
the front left hand corner) using 2 p.p.

<table>
<thead>
<tr>
<th>Task Description</th>
<th>n/a</th>
<th>n/a</th>
<th>/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotate that image 90° to the right hand side and draw how it will look.</td>
<td>n/a</td>
<td>n/a</td>
<td>/</td>
</tr>
<tr>
<td>Draw the above cube in 2 p.p.</td>
<td>n/a</td>
<td>n/a</td>
<td>/</td>
</tr>
<tr>
<td>Draw how the last shape you have drawn will look like when rotated 90° downwards.</td>
<td>n/a</td>
<td>n/a</td>
<td>/</td>
</tr>
<tr>
<td>Draw the above cube in 2 p.p.</td>
<td>n/a</td>
<td>n/a</td>
<td>/</td>
</tr>
</tbody>
</table>

Table 7.10 Two point perspective: students’ work analysis

All but one of the students completed the first task (task d), with 30% of the students drawing 3 different sized cubes excellently. All but one of the students put effort into completing the exercise of drawing cubes using 2 point perspective which had a great success rate as 19 out of 24 students (79%) achieved excellence in this task according to the CaP descriptors. For the third task, despite the difficulty of it, students were guided to draw cubes with parts cut off; most students (22/24) were able to follow but then struggled with aspects of the task, such as rotating the shape in different directions.

Figure 7.18 Perspective: students’ rate of success per task
Refined final descriptors for perspective; drawn after further reflection subsequent to analysis.

The descriptors presented below (Figure 7.19) are placed in an assumed hierarchical order. No empirical evidence has been gathered suggesting the need to know how to draw freehand a 3-dimensional cube in order to be able to learn how to draw cubes using 2 point perspective. Common practice in teaching usually follows a progression from: creating cubes in isometric; to one point perspective; two-point perspective etc.

The descriptors following give an indication of the sequence of stages of understanding required to draw basic cuboids shapes in 3-D and using 2 point perspective, assuming no prior knowledge of 3 dimensional drawing.
Freehand 3-dimensional cube

Correctly draw freehand 3 dimensional cube (the correct number of visible sides to be drawn, according to the point of view)

Draw freehand a correct and accurate cube (3 horizontal parallel lines, 3 vertical parallel lines and 3 diagonal parallel lines)

Basic technique for 2 point perspective

Identify a horizon

Identify the vanishing point
Chapter Seven: Results

Draw a cube in 2 point perspective (2 p.p.) above/ below/ on the horizon
Use 1 vertical line to define the height (the centre line). Connect each end of the line to each vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. From the top point of the each of the last 2 drawn vertical lines, draw a line to the corresponding vanishing point.

Correctly draw a cube in 2 p.p.
Use 1 straight vertical line to define the height (the centre line). Using straight lines connect each end to the relative vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. All vertical lines should be parallel to one another. From the top point of the each of the 2 vertical lines drawn last, draw straight lines to the corresponding vanishing point.

Modifying the basic cube form
Create a drawing to indicating an understanding of how a cube would look like with a piece cut out along a corner.

Communicate correctly a cube with a piece cut out along a corner.
**Figure 7.19 Continuity and Progression descriptors for perspective**

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurately and correctly draw a cube with a piece cut out along the corner. All vertical lines to be parallel to one another, all horizontal lines to be parallel to one another and all diagonal lines to be parallel to one another.</td>
<td></td>
</tr>
<tr>
<td>Draw the above cube in 2 p.p.</td>
<td></td>
</tr>
<tr>
<td>Correctly draw the above cube in 2p.p. Use 1 straight vertical line to define the height (the centre line). Using straight lines connect each end to the relative vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. All vertical lines should be parallel to one another. From the top point of each of the 2 vertical lines drawn last, draw straight lines to the corresponding vanishing point.</td>
<td></td>
</tr>
<tr>
<td>Rotate that image 90° to the right hand side and draw how it will look using 2 p.p.</td>
<td></td>
</tr>
</tbody>
</table>
Delphi group discussions: Validating the taxonomy results on perspective

Table 7.11 lists the areas of concern and responses received on the methodology and results gathered from the study focused on perspective.

<table>
<thead>
<tr>
<th>Areas of concern</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is the methodology presented in the attachment 'Delphi group discussion 4 Perspective drawing descriptors' of gathering data within practice, appropriate?</td>
<td>All participants agreed on the appropriateness of the methodology.</td>
</tr>
<tr>
<td>2. Could this research strategy develop an understanding of progression in this area (perspective drawing) of graphicy?</td>
<td>All participants believed that to be possible.</td>
</tr>
<tr>
<td>3. Given that these descriptors were developed through specific tasks, could they be used more widely for assessment for learning relating to the basic understanding of drawings cuboids freehand and using 2 point perspective?</td>
<td>Half the participants believed that would be possible. No explanation was provided by the participants who believed that would not be possible.</td>
</tr>
<tr>
<td>4. (The final list of descriptors for perspective drawing was provided as in Figure7.20) Would you add, remove or change the order of any of them?</td>
<td>Most participants (75%) believed the list was fine. A small number of the participants believed some stages should be broken into several smaller steps.</td>
</tr>
</tbody>
</table>

Table 7.11 Summary of Delphi study group discussion round 3

Methodology for analysing the results

For the initial analysis of the results from the perspective and rendering tasks, the same method was employed to draw level descriptors and get an initial understanding of the skills and abilities of the students after the lessons. When dealing with the results gathered from the symbolic representation tasks, the results of the task given prior to the lesson and the task given after the lesson were combined. This was deemed necessary because the students illustrated different set of skills and abilities in each task. The main purposes of these tasks were to identify what students can do at this age and draw CaP descriptors by comparing work of different levels.
Validation through the Delphi study

All participants agreed on the appropriateness of the methodology presented for gathering data within practice. The approach has been described to be 'extremely appropriate knowing the scarcity of similar efforts as well as the difficulty for identifying the relevant descriptors in a way that could indicate continuity and progression'. More specifically, it was agreed that this way an understanding of progression in rendering can be developed.
7.2.2 Pilot study 3: star profile

Figure 7.20 illustrates the percentage of completion amongst all 12 students for each continuity and progression descriptor. Only the first 16 descriptors were applicable to the task completed by this group of students. A quarter of the applicable CaP descriptors were completed by all students. These are: ‘drawing 4 axes’, in a ‘neat’ ‘manner, ‘number a scale on the axis’ in a ‘clear’ manner. ‘Drawing each axis 90° one from the other’ and ‘labelling each side of each axis with one evaluation criteria’ was completed by 92% of the students. ‘Clearly labelling each axis’ and ensuring ‘all information to be clearly visible after the completion of the chart’ was completed by 83% of the students. Three quarters of the students successfully ‘connected each point with the next one’ while keeping ‘all information neatly visible’. ‘Neatly numbering the axis’, ‘explaining the numbering system used’ and ‘drawing straight lines to join the points’ for the evaluation were completed by 2/3 of the students. Half the students were able to ‘connect the points accurately’. The least successfully completed CaP descriptor (8%) involved ‘adding only the necessary information to convey sufficiently the information’. The second from the last descriptors with 42% of the students completing it correctly involved ‘neatly labelling each axis’.

![Figure 7.20 Rate of success per continuity and progression descriptors](image-url)
Figure 7.21 illustrates the overall rate of success per student. None of the students completed the task with 100% rate of success (RoS). However, half the students completed the task with higher than 80%. Two students completed the task with 70% or more. One student completed the task with 60% and one with 50% as a rate of success. The lowest RoS achieved was 30%, by one student.

![Overall Rate of success per student](image)

Figure 7.21 Overall rate of success per student

### 7.2.3 Case study 3: Star profile

In case study 4, all 24 continuity and progression descriptors were applicable to the tasks completed. Three of the 24 continuity and progression descriptors were completed by all students fully (Figure 7.22). These are: ‘neatly draw the axis’, ‘number a scale on the axis’ and ‘connect each point with the next’. ‘Label each axis with one criterion’, ‘clearly’ and ‘drawing straight lines to connect each point on the axes’ were competed by 94% of the students. When creating a 4 criteria star profile, ‘drawing each axis 90˚ one from the other’ was completed by 88% of the students, as well as ‘clearly numbering the axes’. More than 4/5 of the students also ‘drew 4 axes (where relevant), ‘connected the points from each axis accurately’ and ‘used a key identifying each product evaluated’. Three quarters of the students drew ‘neatly the numbers on the axes’, ‘all information was clearly and neatly visible after the completion of the chart’. Sixty nine per cent of the students ‘clearly identified each
product evaluation’. ‘Neatly label each axis’, ‘drew 6 axes’ and ‘neatly drawn the (6) axis were completed by 63%’. Half the students drew the 6 axes with ‘60˚ from each one’, ‘drew 8 axes’ which were ‘40˚ from each one’. Drawing the 8 axes with ‘40˚ from each one’ was completed by 44% of the students. Nineteen per cent of the students added a key explaining the numbering system used. All of the students added excess information on the graphs.

---

**Figure 7.22 Continuity and progression descriptors percentage of completion by 16 students**

* - to be able to read it with ease
** - follow the same technique when numbering all axes, i.e. if numbers are placed in front of first axis, it should be placed in front of the other axes too.
- if there is a circle around each number, all circles should all be identical.
- use sharpened lines, uniform in thickness, for all marks (and/or writing).
Figure 7.23 illustrated the overall rate of success per student. A quarter of the students completed the star profiles required with 92% rate of success (RoS). Two of the 16 students did so with 88%, 2 with 79% and 2 with 71% RoS. Three students completed them with 67%, 63% and 58% RoS respectively. Two students completed the tasks with 54% RoS and the lowest RoS achieved was 46%.

![Figure 7.23 Overall rate of success per student](image)

The above results taken from pilot study 3 and case study 4 are presented below in Table 7.12a in the form of a list, starting with the most successfully completed continuity and progression descriptors. Column A represents the shift (up or down) on the hierarchical list of each CaP descriptor between the pilot study and the case study. Column B represents the shift of the results from the case study in comparison to the pilot study.

<table>
<thead>
<tr>
<th>Pilot study 3</th>
<th>A</th>
<th>Case study 4</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. - Draw 4 axes</td>
<td>-4</td>
<td>1. - Neatly draw the axis</td>
<td>0</td>
</tr>
<tr>
<td>- Neatly draw the axes</td>
<td>0</td>
<td>- Number a scale on the axis</td>
<td>0</td>
</tr>
<tr>
<td>- Number a scale on the axis</td>
<td>0</td>
<td>- Connect each point with the next point, following a clockwise or anticlockwise direction</td>
<td>-3</td>
</tr>
<tr>
<td>- Clearly number each axis</td>
<td>-2</td>
<td>2. - Label each side of each axis with one evaluation criteria each</td>
<td>0</td>
</tr>
<tr>
<td>2. - Drawing each axis 90° one from the other</td>
<td>-2</td>
<td>- Clearly label each axis</td>
<td>-1</td>
</tr>
<tr>
<td>- Label each side of each axis with one evaluation criteria</td>
<td>0</td>
<td>- Draw straight lines to join the</td>
<td>-3</td>
</tr>
</tbody>
</table>
3. Clearly label each axis
   - All information to be clearly visible after the completion of the chart +1
     -6
   3. Clearly* number the axes +2

4. Connect each point with the next one
   - All information to be neatly visible after the completion of the chart +3
     -5
   4. Draw each axis 90˚ one from the other (-3) +3

5. Neatly number the axes
   - Explain the numbering system used -3
     -8
   - Draw straight lines to join the points +3
   5. Draw 4 axes -4

6. Connect the points accurately 0
   6. Connect the points accurately 0

7. Neatly label each axis -4
   7. Identify using a key each individual product N/A

8. Add only the necessary information to convey sufficiently the information -5
   8. Neatly** number the axis +3

9. All information to be clearly visible after the completion of the chart i.e. scale numbering, criteria etc. +6
   - All information to be neatly visible (+5) +5

10. Clearly identify each product evaluation N/A

11. Draw 6 axes N/A
    - Neatly draw the axes (6 axes) N/A
    - Neatly label each axis N/A

11. Neatly draw the axes (8 axes) N/A

12. Explain the numbering system used +8

13. Have adequate information (i.e. might not need to number each individual axis) +5
    - Draw each axis 60˚ one from the other N/A
    - Draw 8 axes N/A
    - Draw each axis (out of the 8) 40˚ from each other N/A

Table 7.12a Continuity and descriptors hierarchical list per study

**Refined final descriptors for drawing a star profile**

The descriptors presented below (Table 7.12b) are placed in an overall hierarchical order based on the accumulated results gathered during pilot study 3 and case study 4.
Table 7.12b Continuity and progression descriptors in an overall hierarchical order

Figure 7.24 illustrates the final continuity and progression descriptors for drawing star profiles following the technique taught in the lesson. They are placed in a hierarchical order according to the results gathered from the two classes involved in this study. This offers a possible hierarchical order on the level of difficulty of the descriptors; but due to the small scale of the study, this is not conclusive.
### Star profile continuity and progression descriptors

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Successful</td>
<td>Unsuccessful</td>
<td>Neatly draw the axes</td>
</tr>
<tr>
<td>2.</td>
<td>Successful</td>
<td>Unsuccessful</td>
<td>Clearly* number each axis</td>
</tr>
<tr>
<td>3.</td>
<td>Successful</td>
<td>Unsuccessful</td>
<td>Clearly label each axis (with an evaluation criterion)</td>
</tr>
<tr>
<td>4.</td>
<td>Successful</td>
<td>Unsuccessful</td>
<td>Draw 4 axes</td>
</tr>
<tr>
<td>5.</td>
<td>Successful</td>
<td>Unsuccessful</td>
<td>Draw straight lines to join the points</td>
</tr>
<tr>
<td>6.</td>
<td>Successful</td>
<td>Unsuccessful</td>
<td>Add only the necessary information to convey sufficiently the information</td>
</tr>
</tbody>
</table>

* - to be able to read it with ease  
** - follow the same technique when number all axes, i.e. if numbers are placed in front of first axis, it should be placed in front of the other axes too  
- if there is a circle around each number, all circles should all be identical.  
- use sharpened lines, uniform in thickness, for all marks (and/or writing).
### Chapter Seven: Results

<table>
<thead>
<tr>
<th></th>
<th>Successful</th>
<th>Unsuccessful</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>All information to be clearly visible after the completion of the chart</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connect the points accurately</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neatly label each axis</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>All information to be neatly visible after the completion of the chart</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neatly** number the axes</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Identify using a key each individual product</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Explain the numbering system used</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Clearly identify each product evaluation</td>
<td></td>
</tr>
</tbody>
</table>
Figure 7.24 Star profile continuity and progression descriptors
7.2.4 Pilot study 3: portrait methodology

Tasks 1 and 6 were completed with no help; one before and one after the lesson delivery. Students were asked to draw individually with no help a portrait. Tasks 2-5 were step-by-step guided drawings. Task 7 was completed individually with help available if needed. None of the participants asked for help during the completion of task 7. All participants gained a very good understanding on the theory of drawing portraits correctly. The procedural depth used to teach the correct shapes and measuring the position and size of each facial feature was enough to allow participants to draw very good portraits. Figure 7.25 shows clearly the progression made by each of the participants.

All participants followed tasks 1 to 7 successfully. Different levels of competency were demonstrated amongst the participants for each task. All except participant 4 understood well the technical general structure of the face used as guidelines for the tasks 2-7. This was demonstrated in task 6 where participants were asked to draw a self-portrait, with no help, on a blank piece of paper. The progression can be seen clearly between task 1 (completed before the delivery of the lesson) and task 6, both completed with no help.

All participants were able to follow the step-by-step instructions for drawing a portrait from an angle, given during tasks 4 and 5 well. Most participants showed an understanding of the new knowledge gained as often they would attempt to proceed with their drawings before the next step was demonstrated. However due to time restrictions, no ‘test’ task could be completed for participants to recreate a similar drawing with no help.

All participants except number 4 were able to use the knowledge gained in the first half of the workshop, and incorporate it with the new knowledge delivered on creating caricatures and cartoons. Participant 4 struggled with the technical information delivered in the beginning of the session on the structure of the face. This was primarily evident in tasks 6 and 7. Participant 4 was however able to follow the step-by-step guidance to complete tasks 2 to 5.

All participants showed significant improvement in their portrait drawing skills. This was evident by comparing the outcome of task 1 (prior to the lesson) and task 6 and 7.
Figure 7.25 Participants’ work Tasks 1-7
7.2.5 Case study 4: portrait

Figure 7.26 is placed as a reminder of what each task analysed for drawing portraits was. Tasks are often labelled in charts by the letter representing each one, i.e. Task A is often labelled as ‘A’, Task B as ‘B’ and so on. Tasks A and E were completed with no adult help or guidance. Tasks B and C were completed with step-by-step guidance. Tasks D1 and D2 were completed individually, with help provided where needed or requested.

![Figure 7.26 Portrait and profile drawing related Tasks A to E](image)

The bar chart in Figure 7.27 illustrates the rate of success (RoS) per each individual continuity and progression descriptor. Only the tasks related to each descriptor where taken under consideration. For example, when marking and locating facial features, the first task was not included in the overall rate of success as students were not required to do those stages. Once they were taught the specific technique requiring them to use those marking out CaP descriptors, they were also expected to use them and hence in the relative tasks, they did count towards the rate of success. The bars in the chart are colour co-ordinated according to the part/action related to i.e. the orange coloured bars represent all CaP descriptors related to drawing the ‘eyes’. Appendix 5.3 shows the tables drawn during the analysis of the student’s work, from which the data for the charts below were taken.

At least one CaP descriptor was successfully completed 100% in all task within the parts/actions of drawing the ‘eyes’, ‘nose’, ‘mouth’, ‘hairline’, and the ‘jaw’. Drawing the ‘eyebrows’, ‘ears’ and ‘eyeballs’ did not score 100% for any of their descriptors. Marking out related descriptors achieved a maximum of 75% and 74% as the highest RoS. The lowest RoS achieved was related to drawing the nose, with a 3% of success for ‘drawing the outline for the nostrils starting and ending on the diagonal line’. The second lowest rate was once more associated with drawing the nose; 24% RoS was completed for ‘drawing an arc, starting from one diagonal line reaching the second diagonal line, to indicate the tip of the nose’. However, some of the highest scores were also related to drawing the nose. ‘drawing/indicating a nose’ was completed by all students in all tasks (RoS 100%) ‘indicating the tip of the nose’ was completed with 99% RoS and ‘drawing an arc to indicate the tip of the
nose' and 'drawing nostrils' was completed with 94% RoS. All students acknowledged and attempted to draw the mouth in all tasks (RoS 100%), with 89% drawing clearly both a top and bottom lip. Only half of the times (53%) was a line drawn to separate the two.

Figure 7.27 Rate of success per each individual CaP descriptor.

The chart below in Figure 7.28 illustrates in percentages the overall rate of success (RoS) completed for each of the 10 individual parts/actions required to be completed in order to draw a portrait or profile successfully: mark out feature's location; mark out ratio of features; draw the eyes; nose; mouth; eyebrows; ears; eyeballs; hairline; and jaw. The rate of success
for each relevant task is also shown. However, not all tasks were applicable for assessing all actions. For example, ‘ratio of features’ was only applicable for tasks A, B, D2 and E; it excluded the tasks involving profile drawings (tasks C and D1).

From the graph it is clear that for the first task (task A), none of the students managed to correctly draw the ratio of the facial features whereas in the last task, (Task E), 58% of the students managed to complete that successfully. Both tasks A and E were completed with no adult help, one before and one after the lesson. Drawing the mouth was completed successfully by all students in Tasks B, C and D1. When drawing portraits (Task B and E), the RoS in drawing the eyeballs was 90%. Only half the students (52%) added eyeballs when creating their first portrait (Task A). Relating to locating the features, Tasks B, C and E were completed with a very high rate of success; 98%, 97% and 92 respectively.

The line chart in Figure 7.29 gives an indication of the most and least successful actions completed by all students in all tasks (overall). ‘Ratio of features’ (number 2 on the line chart) has been completed by just about more than half the students, with a 52.5% RoS. Next is the ‘ears’ (number 8); less than 2/3 of the students completed it, with 60.5% RoS and near that is the ‘eyebrows’ (number 6) with 60.8% RoS. ‘Features location’ (number 1) follows with 66.8% slightly more than 2/3 of the students’ successful completion. The ‘nose’ (number 5) was completed with a 69.8% RoS and the ‘hair line’ (number 9) with 70.8%. The ‘jaw’ (number 10) was completed by almost ¾ of the students in all tasks, with 74.8% RoS and so where the ‘eyeballs’ (number 8) with 75% RoS. The ‘mouth’ (number 5) was completed with 80.7% RoS and the most successful action was drawing the ‘eyes’ (number 3) with 87% RoS.
The chart below (Figure 7.30) illustrates the same information as the previous 2 figures, but the data are grouped in a way to illustrate in a clearer manner the rate of success per task. An initial look at the chart indicates that the most successfully completed task was task C, followed by Tasks B and D1.

Figure 7.31 gives a simpler illustration of the rate of success (RoS) of each task. Task A, the first time students drew a portrait before the lesson began, has the lowest rate of descriptors success with 31.9% RoS. The highest rate of success was completed in Task C with 94.3% RoS; the first profile drawing students created in this session and the 2nd task completed
with step-by-step guidance. Similar success was noted for Task B with 88.8% RoS; the 1st task completed with step-by-step guidance. Tasks D1 and D2 also scored a similar rate of success between them (73.4% and 68.9% respectively) with Task D1 (portrait) scoring 4.5% higher than Task D2 (profile). The last task, Task E was created with no adult help and scored a higher rate of success than Tasks D1 and D2 with 75.8%. The red line in Figure 7.31 illustrates the progression students achieved from the beginning of the lesson until the end of the lesson, with an increase of 43.9% RoS. The Black line indicates the RoS per Task.

![Figure 7.31 CaP descriptors overall rate of success per task](image)

Table 7.13 lists the sequence of task starting from the highest to the lowest rate of success. Task C has been the most successfully completed task in 9 out of 12 students. Task B has been the second most successfully completed task in 8 out of 12 students. In 2 occasions it was completed with the best rate of success. The task D1 is the most scattered task within the hierarchical order table. It was completed by 10 students, 4 of which completed it with the second from last RoS. Only 1 student completed task D1 with the highest RoS, and another student completed it with the second higher RoS. Task A scored the least by all students. In most cases (8/12) task E was the third most successful task, often after tasks C and B. Task D2 was also completed only by 10 students, 7 of which completed it with such a RoS, placing that as the fourth most successfully completed task.

<table>
<thead>
<tr>
<th>Student</th>
<th>In hierarchical order, starting from the highest rate of success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C, B, E, A</td>
</tr>
<tr>
<td>2</td>
<td>C, B, D1, D2, E, A</td>
</tr>
<tr>
<td>3</td>
<td>C, B, E, D2, D1, A</td>
</tr>
<tr>
<td>4</td>
<td>C, B, E, D2, D1, A</td>
</tr>
<tr>
<td>5</td>
<td>B, C, D2, D1, E, A</td>
</tr>
<tr>
<td>6</td>
<td>E, B, C, D2, D1, A</td>
</tr>
</tbody>
</table>
Table 7.13 Tasks A – E in a hierarchical order according the overall rate of success

Between tasks D1 and E, 5 out of 10 students showed an increase within the RoS of each task, 4 showed a decrease and 1 scored the same. Figure 7.32 shows the most consisted deep angle is created between task A and B, illustrating the biggest difference between the rates of success in the task before them and the tasks after them. The pattern of the red lines also demonstrated that all students’ RoS increased dramatically in tasks B and C, and in most case it dropped significantly in tasks D1 and D2. All 12 students showed improvement from the first task they completed with no guidance, task A, to the last task completed with no guidance task E. One student (student 6) achieved the highest rate of success during the independently completed task E. Eight out of the 12 students did better in task C than B.
Figure 7.33 Rate of success per task, for each student
7.3 Collaborations

7.3.1 Pilot study 5: co-research (methodology and results)

Pilot study 5 was completed in collaboration with Samantha Lyne in 2010, a PGCE student from Sheffield Hallam University. Lyne had the opportunity to teach one lesson every two weeks with Year 7 on food technology, where she focused on nets and food graphics such as logos, signs, symbols, colour and branding. Her Year 8 class had, as a main focus, basic graphic skills. Both years were taught about the use of colour and branding when creating logos. Students’ work has been documented and some of the results from this study are reported below.

Lyne worked with 24 Year 7 students and 22 Year 8 students. The main focus of the study was on symbolic representations. An initial list of CaP descriptors was developed based on literature review which enabled tasks to be developed to test and teach graphicacy skills in this area. Two main tasks were developed, looking at skills needed to analyse existing logos, and the skills required to create new logos based on given themes. Analysis of the students’ response and work on those tasks have enabled a refined CaP descriptors list to be developed which were categorised under Years 7, 8 and 9 headings by Lyne (Figure 7.33).

Analysis

The graph below (Figure 7.33) illustrates how the students performed in the tasks before, during and after the lesson on symbolic representations was taught. Girls appeared to score higher before and during the lesson. Boys appeared to have very low to no score at all before the lesson, but there is a rapid improvement after the lesson is taught. Both girls and boys show understanding in the first 6 criteria which have been placed within the Year 7 scope of abilities by Lyne. Girls show understanding in some criteria within the Year 8 scope.
Quoting Lyne; ‘the boys (in Year 7) can only do the same things as the girls at this stage. This is an unexpected result as the class had been taught all strands included in the graph above. It was expected that individuals would learn things at different stages’. Lyne (2010) reported that this might be suggesting a hierarchical order within the CaP descriptors.

... ‘none of the students from year 8 have reached any criteria in the year 8 CaP descriptors section’ at the initial stage of demonstrating their knowledge before any teaching and learning was conducted on this area. This might be an indication of where nature stops developing graphicacy skills and where nurture is needed for further development (Lyne, 2010).

The value of this intervention

Having the opportunity to work with teacher trainees to further this research through co-research, has tested the research strategy and methodology adopted during the analysis of CaP descriptors for elements of graphicacy. This was so, as the methodology had to be clear and precise enough for a ‘new’ researcher to follow it. Collecting common results from a range of teachers working with different groups of students strengthened the reliability of the
results. Having a number of teachers’ expertise influencing this process also improved the validity of the outcome.

The PGCE students had the opportunity to see step-by-step how to deal with their assignment on one area of research which would be helpful to them even if they had chosen a different area to work in.

One of the co-researchers (PGCE students) commented;

‘Based on teaching my lessons, co-research has taught me a lot about the lack of awareness around Graphicacy and the fact that pupils need to be given more detailed instructions to help them achieve their full potential and to challenge their abilities further. I had never even heard of Graphicacy and as a design and technology teacher it has now become a real focus within my teaching’.

Lyne

The course leader John Robson stated;

‘There have been real benefits for the PGCE students who have engaged in this collaboration (co-research) and can be summarised as follows:

- Co-research provided a suitable focus for students’ assignment work
- An involvement in a ‘live’ and on-going research project was enabled
- A model for action research has been provided which assisted student understanding and personal methodologies
- Student awareness has been raised about the importance of graphicacy and associated issues around teaching and learning
- Periodic and individual tutorial support was provided by the author
- A comparison of the graphicacy project with the requirements of the students’ assignment has facilitated a better understanding of the latter
- Students have been encouraged to participate in and make real contributions to research activity in Design & Technology Education’

7.3.2 Case study 5: co-research

No results were obtained from the PGCE students’ performance or research results in time for this thesis submission.

7.3.3 Delphi study group as a method

In general there has been a very positive reaction towards the discussions brought forward in this study. The research has been described as very interesting and ‘extremely good work that could prove to be helpful from many respects’. The methodologies described for various
research has been approved and deemed as appropriate for each relevant study. The Delphi group study brought up and identified some very important issues relating to this research. A number of agendas have been defined relating to continuity and progression (CaP) descriptors. These will be targeted to be addressed during the discussion part of the thesis. A number of references were also provided during this study, which will aid in updating the existing literature review. Table 7.14 summarises the areas of discussion in Pilot study 5 (round 1 of discussions) and Case study 6 (rounds 2-4 of discussion) and gives a summary of the result for each one. One participant was not able to continue with the study due to the short deadline provided for each round’s responses. Participants were given one week to read the material sent to them and sent back a reply. This was designed based on the areas needed to be covered through the study and the time available before the end of the thesis.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Actions / responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Round 1: The taxonomy of graphicy</strong></td>
<td></td>
</tr>
<tr>
<td>Do you think the Delphi group method described is appropriate/ doable?</td>
<td>All participants agreed on the appropriateness of the Delphi study group.</td>
</tr>
<tr>
<td>Are the categories within the taxonomy for graphicy the ones you would expect? Please indicate if you consider each category appropriate or not (the taxonomy was illustrated in a Figure)</td>
<td>Discussions resulted in making some changes such as:   - remove CARTOONS from the sequential category  - Move photographs into a separate category  - Change the title of the ART category to WESTERN ART</td>
</tr>
<tr>
<td>Are there any elements which you feel have been missed out?</td>
<td>Some strong opinions were shared on the importance of GRAPHIC ARTS as part of the taxonomy</td>
</tr>
<tr>
<td><strong>Round 2: Cross-curricular links</strong></td>
<td></td>
</tr>
<tr>
<td>Do you think ‘version 2 of the taxonomy is a comprehensive and appropriate research tool for research in an educational context with regards to the types of images and the graphicy skills (the ability to communicate [code &amp; decode] information through still visual images) required to deal with them’?</td>
<td>All participants agreed on the statement provided. The importance of viewing the taxonomy as a work-in-progress was emphasised.</td>
</tr>
<tr>
<td>Do you think breaking up the taxonomy into 25 types of images was the appropriate method for a research tool to be used in the study described above?</td>
<td>All participants were in agreement with the appropriateness of the taxonomy used during the cross-curricular analysis of textbooks.</td>
</tr>
<tr>
<td>Is there anything within the results illustrated in Figure 2 which is unexpected?</td>
<td>Most participants expected a lot more variety of graphicy elements to be studied during art classes.</td>
</tr>
<tr>
<td>Do you think the cross-curricular links indentified are equally appropriate for inbound and outbound graphicy skills (coding and decoding information)?</td>
<td>More than half of the participants (60%) believed the cross-curricular results could be different if broken down into inbound or outbound</td>
</tr>
<tr>
<td>Question</td>
<td>Participant Response</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Is there a difference between the level of difficulty in dealing with coding and decoding the same type of image?</td>
<td>All participants believed that there is going to be a difference in difficulty.</td>
</tr>
<tr>
<td>Do you think one can acquire outbound graphicacy skills (coding/creating an image) without having obtained the required inbound graphicacy skills (decode, read and understand information) relating to the same type of image?</td>
<td>Most participants (80%) believed it would not be possible to acquire outbound skills without having obtained the required inbound skills relating to the same type of image.</td>
</tr>
</tbody>
</table>

**Round 3 rendering descriptors**

<table>
<thead>
<tr>
<th>Question</th>
<th>Participant Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the methodology presented in the attachment 'Delphi group discussion 3 Rendering descriptors' for gathering data within practice, appropriate?</td>
<td>All participants agreed on the appropriateness of the methodology.</td>
</tr>
<tr>
<td>Could this research strategy develop an understanding of progression in this element (rendering) of graphicacy?</td>
<td>All participants believed that to be possible.</td>
</tr>
<tr>
<td>Do you think the descriptors generated would be useful during assessment for learning relating to rendering?</td>
<td>The majority of the participants (67%) believed that would be useful.</td>
</tr>
<tr>
<td>(The final list of descriptors for rendering was provided in a list) Would you add, remove or change the order of any of them?</td>
<td>Most participants (67%) believed that list was fine as it was.</td>
</tr>
</tbody>
</table>

**Round 4 perspective drawing descriptors**

<table>
<thead>
<tr>
<th>Question</th>
<th>Participant Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the methodology presented in the attachment 'Delphi group discussion 4 Perspective drawing descriptors' of gathering data within practice, appropriate?</td>
<td>All participants agreed on the appropriateness of the methodology.</td>
</tr>
<tr>
<td>Could this research strategy develop an understanding of progression in this area (perspective drawing) of graphicacy?</td>
<td>All participants believed that to be possible.</td>
</tr>
<tr>
<td>Given that these descriptors were developed through specific tasks, could they be used more widely for assessment for learning relating to the basic understanding of drawings cuboids freehand and using 2 point perspective?</td>
<td>Half the participants believed that would be possible. No explanation was provided by the participants who believed that would not be possible.</td>
</tr>
<tr>
<td>(The final list of descriptors for perspective drawing was provided in a list) Would you add, remove or change the order of any of them?</td>
<td>Most participants (75%) believed the list was fine. A small number, believed some stages should be broken into several smaller steps.</td>
</tr>
<tr>
<td>Do you think the descriptors under the title 'basic technique for 2 point perspective could also be applied when working with 1 point perspective?</td>
<td>Most participants (75%) believed that the list could be applied also when working with 1 point perspective.</td>
</tr>
<tr>
<td>Would you suggest using more fluid forms as a starting point for introducing the</td>
<td>All participants agreed this would not make an ideal starting point but it is</td>
</tr>
<tr>
<td>Question</td>
<td>Response</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>concept of rendering?</td>
<td>something that should be introduced eventually.</td>
</tr>
<tr>
<td>Do you think it would be appropriate for year 7 students (ages 11-12)?</td>
<td>The opinion on this question was divided as 50% believed it would, and the other 50% believed it would not.</td>
</tr>
<tr>
<td>Can young students go straight into understanding the philosophy of rendering by working on more fluid forms?</td>
<td>Most participants believed that would not be possible. However, 25% believed it would be.</td>
</tr>
</tbody>
</table>

Table 7.14 Delphi study group areas of concern
7.4 Summary

The results gathered during this study have been placed in three main areas. These are:

- Graphicacy across the curriculum;
- Continuity and progression descriptors for elements of graphicacy, and;
- Collaborations.

The results relevant to ‘graphicacy across the curriculum’ are illustrated in Figures 7.34 and 7.35. Figure 7.34 summarises the results for the creation and development of the main research tool used in this study.

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Figure 7.34 Results: Research tool

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Figure 7.35 summarises Pilot study 1 and Case studies 2 and 3 related to identifying graphicacy across the curriculum.
Figure 7.35 Results: graphicacy across the curriculum

All the results relevant to continuity and progression descriptors for graphicacy elements have been summarised in Figure 7.36. The figure includes the results from Pilot study 2 (the workshop), Pilot study 3 and Case study 3 (star profile) and Pilot study 4 and Case study 4 (portraits drawing).
The results gathered from the collaborations formed during this study, including co-research and Delphi study groups are summarised in Figure 7.37
Figure 7.37 Results: Collaborations
CHAPTER EIGHT

Discussion

Introduction of Chapter 8

This chapter raises and discusses issues arising from the analysis of the data collected and in relation to the literature review. This discussion is organised in relation to the research questions which have been grouped to provide an appropriate structure. The relevant research question numbers have been put in brackets where they apply. Details of the literature review discussions can be found in Chapter 5. The results on graphicacy across the curriculum and the research tool developed enabling that research to take place is discussed in Section 8.1, referring to RQ 8. The overall results from the study on graphicacy use across the curriculum are then discussed (RQ 2, 5, 6 and 7). Section 8.2 brings forward the debate of nature versus nurture (RQ 9 and 10). Potential ways of measuring graphicacy through tasks (RQ 3 and 4) is discussed and comparison made with other tests which use graphicacy to measure intelligence, mental or psychological states. Section 8.3 is focused on continuity and progression descriptors, identifying stages of drawing and the abilities of children aged 11-14 (RQ 9 and 10). The methodology used is discussed with a primary focus on its strengths and weaknesses (RQ 8). The extent to which graphicacy’s potential has been exploited is discussed (RQ 12). Some initial indications towards how fundamental graphicacy is to students’ progress (RQ 11) and the potential offered by graphicacy (RQ 12) are given. The potential of co-research as a research strategy is discussed in section 8.4, relating to RQ 13. Section 8.5 outlines areas for future research based on the results gathered by this research, referring amongst others, to RQ 11.

Research Questions

1. What is graphicacy?
2. Has graphicacy across the curriculum been studied before? If so, what were the findings?
3. How can we measure graphicacy?
4. Are there existing ‘graphicacy tests’ or tests based on the skills of creating images?
5. Where does graphicacy fit across the curriculum?
6. How does graphicacy appear in ‘teaching’ (within the sample of schools and subjects studied)?
7. What are the main similarities of the use of images across different subjects?
8. Are there established methods for studying graphacy within the curriculum?
9. Are there main stages/levels of drawing, mark making or other graphacy related abilities that children go through?
10. How does graphacy capability change/develop during the years of 11-14 years?
11. How fundamental is graphacy to students’ progress?
12. Is the potential offered by graphacy fully exploited for the learning of all students?
13. Can co-research provide useful data for this research?
8.1 Graphicacy across the curriculum

The potential offered by graphicacy, within pedagogic strategies, was well recognised across the curriculum, as all textbooks analysed used images to enhance learning in a number of ways.

8.1.1 The taxonomy of graphicacy

The taxonomy developed for this study has been designed specifically to be used as a research tool during the analysis of textbooks for identifying graphicacy use in education. Referring to RQ 8, a number of different types of taxonomies exist, designed to deal with graphicacy within educational research, focused on various taxonomic dimensions. Some of these taxonomies have been placed in a taxonomy of taxonomies, under the following dimensions: the representation, the message, relation/correspondence, task and process, context and convention and mental representation. The taxonomy created for this study was heavily influenced by a taxonomy of graphs created by Fry in the 1970s. Fry's taxonomy was mainly focused on representation based on the graphic structure and the visual/spatial relations related to these. The new, up-to-date taxonomy created for this research was focused on the representation (graphic structure), task and process, which include information processing (perception and problem solving) and tools (interaction with the representation). This served two purposes; identifying graphicacy use across the curriculum and the beginning of creating tasks and tests to measure competency in various graphicacy elements. As noted in Chapter 7, all participants from the Delphi study group agreed that Version 3 of the taxonomy is a comprehensive and appropriate research tool for research in an educational context with regards to the elements of graphicacy and the skills and abilities required in completing these successfully.

The taxonomy is considered a work in progress and variation and extensions of the taxonomy are possible for future research within practice. Focusing primarily on representation, each category within the taxonomy can be broken down into the various types of image i.e. different types of maps, charts etc. The taxonomy could also be developed according to the level of difficulty in understanding, reading and/or creating each different element of graphicacy. Categorising the images in the taxonomy to serve the above purpose, would require the primary focus to be shifted towards mental representations. However, to achieve this, further research would be required in order to establish levels of difficulties. An age level for the target group has to be specified i.e. KS 3 students, advanced diploma level, professionals etc.
8.1.2 Overall results

There is a lack of graphicacy policies or strategies within school curricula. This can be seen from the way graphicacy is used in different subject areas across the 3 schools. For example, sequential images have been identified as one of the most popular elements of graphicacy used across the curriculum (RQ 6). Within the physics textbooks analysed across the 3 schools, sequential images were completely missing within the Cypriot textbooks for physics. This might suggest that there is no clear published information on the benefits of using such images. The teachers (or textbook writers/designers) of physics in Cyprus are possibly unaware of the benefits of using sequential images which seem to be apparent to the teachers or the textbook designers in England and the USA. This is a fair reflection of the results of how graphicacy is used in the textbooks used in the Cypriot schools, since all schools use the same textbooks. However, both the schools in the UK and USA represent a category of schools, and hence the type of textbooks typically used within that category. The school in the USA could reflect the academically high achieving grammar schools. The UK school could reflect the schools which aim to reform their curriculum and teaching strategies away from the ‘strictly academic teaching strategies’ and move towards a friendlier and ‘child appropriate’ strategies. Due to the small sample of countries/schools involved with this study however, the above suggestion cannot be conclusive.

The limited variety of graphicacy elements dealt with in the subject area of art in the Cypriot and USA school was unexpected (RQ 5). The art lessons looked at for this research, in both Cyprus and the USA, seem to be mainly focused on the pictorial type of images. This could be for a number of reasons i.e. ‘simple’ curriculum design or lack of experience or enthusiasm by the teacher. Other elements affecting the quality of art lessons delivered could be the senior members of the school’s staff as well as the student parents’ perception of the subject’s importance. This does not match current practice in England as described further in this section based on practice witnessed in the case study school and this author’s prior professional experience. It would also be an unfair representation of schools’ practice in either Cyprus or USA, due to the small sample of schools involved. From discussions with the teachers in both schools, it was obvious that the individual teachers were responsible for the selection of the textbooks involved and the curriculum taught.

It has become apparent that students will work as hard as they are expected to, as long as they have the appropriate support (RQ 6). This was an observation identified during the interviews with the teachers from the Cypriot school. A religious education (RE) teacher shared her genuine enthusiasm about images, in specific, Greek Orthodox religious paintings. During her lessons she used in-depth analysis of common techniques for painting the original pieces discussed. This was clearly influencing her lessons and the students’ outcomes. Their exercise books had a lot of drawings focused on the technique used in such paintings and other illustrations as part of the students’ answers/homework. She would often
hold class discussions about the terrain, distance and environmental circumstances religious figures would have come across, by analysing maps. Within the same school, children of the same age range and possibly the same students were dealt with differently by other teachers. The history teacher, for example, shared a completely different view; she stated that 12-and 13-year old students do not have the capacity to understand maps, so she did not place much emphasis on them during the lesson, even though they often appeared in the textbooks used for the lessons. The above illustrates common practice, where individual teachers’ expectations often become the measure of students’ limitations and potentials. This also demonstrates the need for a graphicacy strategy to be in place, affecting all subject areas.

This is also supported by the graphicacy cross-curricular links identified in all subject areas analysed in all 3 schools. For example, the analysis of the UK school’s textbooks has identified links between mathematics, science, design and technology and geography through the use of engineering and technical drawings. In the Cypriot textbooks, all subject areas analysed except art and Greek language, use spider diagrams. In the USA textbooks, all subject areas expect ICT Java and art use charts and graphs. This evidence suggests that graphicacy is a key element within the curriculum in much the same way that literacy and numeracy are.

The research tool (taxonomy) used in the cross-curricular analysis was broken down into 25 graphicacy elements. The same research tool could be used to provide information in a more general manner, by using either the 7 subheadings (graphic arts, drawings, diagrams, sequential, abstract, spatial and CGI) or the 4 main headings (pictorial, sequential, symbolic and CGI). The format of the research tool would not have provided different answers to the relevant research questions. It would have provided a different level of detail both in the analysis and the results. The level of detail used to tackle each research question was chosen according to the task at hand.

The lack of research on graphicacy and how to use it effectively across the curriculum leading to inconsistent uses of graphicacy were identified (RQ 2). This fact makes the similarities within the pattern of graphicacy (RQ 7) use across the 3 schools even more peculiar. It is very unclear as to how such similarities arose, when it is clear that there is no shared policy or strategy suggesting the best way of using graphicacy within education. The most commonly used image overall in the textbooks analysed by all 3 schools were the photographs. As with all elements of graphicacy, there are numerous different types of image under each category. However, most photographs used in the textbooks were the typical realistic imprint of whatever was photographed in real life. One of the explanations for the use of the most popular elements of graphicacy used in textbooks might lie in the textbook designer’s preferences. For example, textbook designers might like photographs as they can liven-up the book. In a similar way, graphs and charts might have been so popular because
they can save space in a book, considerable information can be communicated through them. In addition, the fact that those images are found in the textbooks, does not translate to the way each individual teacher uses images during the class. Some teachers often put more (or less) emphasis on them than others.

Some of the least used elements of graphicacy appear to be subject-specific. For example drafts, life drawing, portraits and still life are often used in art and design and technology, but are not ‘key’ in learning mathematics. An indication towards the subject areas which could carry the main responsibility in teaching graphicacy by incorporating a graphicacy strategy within the national curriculum have been identified through the analysis of textbooks. All subject areas analysed during the study were plotted against the number of types of images from the taxonomy. The ratio between the types of images used per subject was investigated.

The results revealed that most subject areas use images from all four main categories of the taxonomy. The subject area, within the range of subjects analysed, which used the biggest variety of images in teaching in England and Cyprus was design and technology (22/25 and 18/25 equivalent). Since the opportunity to conduct research within this subject area in the USA was not available, we have no indication towards the way it is taught in the USA. Through the informal discussions with the teacher, we do know that as with the subject area of art, design and technology was not considered a ‘serious’ subject area in that school. Hence, there is no indication suggesting that researching the use of graphicacy in design and technology as taught in that school would have provided a fair representation across most USA schools.

Art was not part of the case study because the teachers’ practice did not reflect the common practice found in most English schools. From personal discussions with the teacher, it was clear that a large number of different graphicacy elements were studied for KS3, unlike the limited range studied in schools A and B. The teacher exhibited exceptionally good practice. There was no fixed repertoire of teaching resources for the lessons. Instead, there was library full of books and resources, as well as a rich online library. Resources were used according to each individual lesson task and group of students. This practice, even though it can be considered a well-designed and thought off teaching strategy, would not have provided biased results on how commonly graphicacy is used across the subject area of art. The subject area which used the biggest variety of images in the USA was calculus (14/25). The primary focus of calculus is numeracy, which is often re-enforced through graphicacy. This would be expected to be a fair reflection of graphicacy use during the teaching of calculus in most schools, as graphicacy appears to be a required teaching tool. Hence, graphicacy can be considered a tool often used to obtain or illustrate a mathematical answer. Gaining an understanding of how to use graphical means would be sufficient for this purpose. It would be unrealistic to expect part of the primary focus of the lesson to be shifted towards teaching the understanding of the function graphicacy elements can have. It would be more sensible to
expect design and technology or art and design, or a collaboration to be formed between the 2 subject areas, to take up the primary responsibility of consciously teaching graphicacy. A cross-curriculum graphicacy strategy could be incorporated to enable a unified graphicacy policy to be incorporated and used in all applicable subject areas where relevant. This would not require a great deal of changes within the design and technology curricula in the UK and Cyprus, but the nature of curricula in this subject area varies around the world. In the UK and Cyprus, it would merely require the identification of the already taught graphicacy elements and based on that, the development of a graphicacy strategy. In countries that have adopted a more technological than designi-based approach (eg the US), then greater development of the subject area would be needed if it was to serve this more general purpose.

8.1.3 Similar patterns of graphicacy use
The pilot study was conducted through an analysis of textbooks using the taxonomy accompanied by teacher interviews. Therefore unsurprisingly, the emerging results of the data analysis showed patterns from teachers’ perspectives (RQ 5 and 6). These results showed similarities of graphicacy use across the 3 schools. This was unexpected for the following reasons:

- School A was in Cyprus; School B was in the USA; and school C was in England.
- Schools A and C are lower schools with students between 11-14 years old; School B is an upper school with students between 16-18 years old.
- School A is a government funded school with no admission fees and it is a low to middle-class school with average in students’ levels and achievements. An average percentage of students are expected to attend higher education. School B is a private school with admission fees ranging from $20,000 to $33,000 per year and is considered to be a very high achieving school. All students are expected to go to further education. School C is a government funded lower school with no admission fees. Students are considered to achieve average grades.
- Textbooks in School A are given free of charge by the government. All government funded schools in Cyprus use the same textbooks. Textbooks in School B and C are selected every year by the departments and individual teachers. For School B, pupils are expected to buy the selected textbooks for each subject area.
- The highest degree most teachers from schools A and C obtained was a university teaching degree. The standard degree level for most teachers from School B was an advanced level degree or doctorate.
- Teachers in school A did not feel comfortable with the idea of talking to a researcher. Teachers in school B and C considered it perfectly normal talking to a researcher.
- School A teaches subjects in Greek. School B and C teach subjects in English language.

A number of variables deem these results to be surprising. For example, the fact that they were gathered across three different cultures within three different education systems. One
would expect significant differences to appear. In addition, the textbooks analysed were created, edited, and printed in three different countries. The USA textbooks were designed for older, more mature students, whereas English and Cypriot textbooks were aimed at younger children.

Within the Cypriot culture, it might be expected that in a private school where there are higher achieving students, fewer images would be used, and students would be expected to learn with more traditionally academic methods. In government funded schools with less motivated students (and often teachers), it would be expected to see an increase of image use in an attempt to attract the attention of the students during the lesson. Furthermore, all textbooks are chosen by people with different academic backgrounds and credentials (i.e., in Cyprus they are chosen from a board of experts; in the USA school by the individual teachers and in the English school by each department).

Despite all of the above, the pattern of graphicacy use (referring to RQ 7) appeared similar across the three schools, which raises the question, “Why is this so?” The methodology used for the data gathering and analysis was developed to ensure unbiased results, which should exclude this from being the reason for the similarities in the pattern. These similarities could result from the:

- selection of subject areas surveyed;
- understanding of professional graphic designers’ correct use of images in the classroom;
- the way people currently believe the information should be communicated, reflecting culture and fashion in this field;
- teaching training courses, training teachers to use images in a similar way;
- reflection of research in this area;
- be an incidental coincidence.

On the other hand, a different reason for the emergence of the similar patterns could be that graphicacy is an international language used in similar ways across different countries and cultures. As noted earlier in Chapters 2 and 7 (sections 2.3 and 7.1.5), purposes of image use were identified, which included: constructing and managing production, exploring ideas, communicating key points to other people, highlighting features, setting out a structure, supporting calculations for technical details, planning and organising, and promoting imagination. This would not be a complete or an exhaustive list, but it indicates the kind of purpose for which graphicacy could be used. The matter is too complex to resolve in this thesis. The consequences of the lack of research in the field and the potential benefits graphicacy strategies could bring have begun to be identified. It does provide, however, a strong indication towards the importance of graphicacy across the curriculum. The results do not provide conclusive evidence to either support or contradict the findings of the literature where graphicacy is proposed as being subordinate to literacy and numeracy. It does
however provide a strong indication towards the so far neglected importance of graphicacy across the curriculum.

The above unexpected results fuelled the interest in conducting quantitative analysis in a number of areas of this study. Immediately recognisable patterns were sought, as with the results gathered on the graphicacy use across the 3 schools. In most cases, small indications of patterns emerged, but no conclusive evidence in relation to the research questions of this study were collected. It did however; provide some interesting starting points for potential future research. For example, further research and analysis could be focused on the RoS of specific CaP descriptors. This study has provided through the RoS percentages some initial indications of graphicacy level expectations. These could form as guidelines for teachers, on what they could expect children of certain age to be able to comprehend through teaching and learning. The statistical results on graphicacy use across the curriculum could be researched and analysed further to form a comparison between the use of graphicacy, numeracy and literacy across the curriculum. This could prove or disprove the idea sometimes supported in the literature, regarding graphicacy being subordinate to literacy or numeracy.
8.2 Interpreting students’ work on graphicacy

The literature which suggested that the tests which take elements of children’s graphicacy as a measure for their general intelligence level or emotional state (referring to RQ 4) by assessing the work against fixed criteria appears to be even less convincing after the analysis of this thesis results. The way the criteria lists are drawn for the tests is not too dissimilar with the methodology used to draw the CaP descriptors. In both cases, the criteria (or descriptors) are drawn through research by identifying the common and unique characteristics and elements within a large number of drawings taken from children’s work. The tests which use graphicacy elements to measure something else (i.e. intelligence etc) base their assessment on set criteria of the drawing characteristics as completed by the ‘average/ normal’ children. The creation of CaP descriptors is drawn through analysis of students’ work, identifying differences, misinterpretations and/or ‘mistakes’. The big difference lies in the way the identified criteria are used. For the CaP descriptors, these criteria are used to pin-point potential areas of difficulty for students and help breakdown in more detail the initial CaP descriptors list. For the tests using graphicacy to measure something different, any characteristics drawn (or not drawn) beyond the listed ones are taken as indications relating to the intelligence, emotional or psychological state of the child. However, from a failure to achieve any one of the set criteria, it is doubtful one can get a true reading on what is going on inside a child’s mind based on the evidence reported so far in the literature. There has been no substantial evidence to support the connection between children’s intelligence, mental or psychological state, and characteristics of drawings such as including (or not) buttons on a human’s shirt. An example provided by Kellogg (1907) and one taken from the results of this research are used below, indicating the theory used by such tests as potentially invalid.

One example illustrating the misinterpretation of children’s graphicacy skills was given by Kellogg (1970 as referred to in Chapter 4). Figure 8.1 shows the drawings of an 8 year old boy who achieved an I.Q. score of 80 which placed him in a class for a student with serious learning difficulties (referred to as ‘mentally retarded’ by Kellogg, 1970). From the drawing below it is obvious that the student has highly developed cognitive modelling and graphicacy skills. For the drawings below to be completed, one has to imagine in the ‘mind’s eye’ how a goose looks like while flying, the possible movements of the wings, the beak, the body and the feet. The ‘normal’ schematic representation often created even by adults, would consist of drawing the wings in an upright position, the beak to be closed and depending on the age of the artists, the legs might not appear at all, or be drawn in a walking position. This 8 years old student, can draw fine detail illustrating motion, for more than one subject i.e. geese, horses and knights.
The tests which use graphicacy to measure something else are often based on the assessment of one drawing. The effects of the environment, current mood, daily events or guideline misinterpretations which often influence children’s actions, and hence the outcome of their drawings, are not taken under consideration.

The results of this author’s research support the importance of judging children on their full potential, instead of the outcome of their work on one given day. The CaP descriptors are created for use as teaching and learning guides (referring to RQ 3). The teaching aims represented by the CaP descriptors include; gaining the understanding required to successfully create a graphicacy element to communicate information clearly and correctly. Figure 8.2 illustrates some potential ways the CaP can be used to interpret students’ understanding.

Two examples of ‘wrong’ star profile charts next to a ‘correct’ version of the chart are illustrated below. If a fixed list of assessment criteria was to be established (as is the case with the ‘Draw-a-man-test’ and similar approaches) for illustrating the information clearly using a star profile chart based on the first image illustrated, the other two images would be assessed as wrong, even though that might not be the case. If one were to attach a secondary meaning to the results, we might have assumed that student (1) is more intelligent than the other 2 students. However, it might also mean that student (1) was more alert and concentrated in the lesson than the other 2 students. Further analysis of the work, shows that the second image (labelled as ‘Wrong’) is illustrating the information clearly. The chart is clearly divided into 4 equal parts, clearly labelled and marked with a scale. Depending on other criteria used for assessment, this chart might be considered wrong, ‘innovative’ or
‘ingenious’. If part of the assessment was on creativity, student (2) would score well as this is an unusual way (created by the student) to clearly communicate information. This would be so assuming that the child has a full understanding of the correct ‘conventional’ way of creating a star profile, but has decided to re-create the chart, in a new way, while maintaining the same purpose for the chart. On the other hand, graphicacy is often used as a national or international language. If part of the assessment criteria was based on creating the star profile ‘correctly’ i.e. following the standards as used nationally/internationally, then the chart would be considered wrong.

Despite the final assessment of learning described above, the CaP descriptors can (and should) be used for assessment for learning. By analysing the 3 pieces of work (referring to RQ 3) illustrated in Figure 8.2, it is clear that student (1) has gained a secure understanding of the function of the chart in general, and each individual part making up the chart. Student (2), however, seems to have gained a clear understanding of the purpose of the chart profile, but not the purpose of each part of the chart. The handouts provided to the students had lightly drawn circles to help the students draw and label the axes within the intended space on the page. This student used the axes as divisions and each quarter of the circle (provided by the guidelines) has been labelled with a scale and an analysis criteria. A key was provided (not shown in the figure below) explaining both the scale and the colour code used. The student either did not understand the ‘correct’ use of an axis, or decided to use his/her way which was different and hence more exciting, while communicating the intended information. Either way, the results indicate a pro-active approach, which is different from the ‘norm’. The student has ‘invented’ a new, effective way of re-creating the traditional star profile chart. The student’s ‘mistake’ has been identified, and assessment for learning can be targeted to the specific area needing attention.

Comparing the first and last examples, it is clear that student (3) who created the image labelled as Wrong, did not understand either the way the small lines are commonly used to mark out the exact point on the axis for each number when drawing or using a scale, or that the axis is the line used as a measuring element. Instead, the student referred to the numerically written numbers to indicate the score for the analysis. It is also clear that the student did not understand why we mark out the scale in a certain manner i.e. where lines intersect is the beginning of the line and therefore is marked as 0. Keeping this rule constant will allow the reader instant pattern recognition concerning the data illustrated. The 3 students who created the star profiles below were not sitting at the same table. It is therefore unlikely for student (3) to have copied the idea of emphasising the chosen number on the axis by copying student (2). It is more likely that student (3) considered the axes as divisions of the space. The small lines could have been used as a marking method for the placement of the numbers (therefore the numbers carry a bigger importance than the small lines in this case),
and the numbers themselves were used to illustrate the assessed level of success for each analysis criterion. This student seems to have gained some understanding on the purpose of the axis but not the ‘correct’ use of the axis. Despite that, the information has been illustrated clearly.

**Information illustrated:**

1. Correctly
2. ‘Wrong’
3. Wrong

![Figure 8.2 Star profile charts by Year 7 students](image)

With the information gained so far from this research, it is not possible to judge anything other than the students’ understanding of the overall function of the chart and the purpose of each individual part of it. There has been no evidence found through the literature or this research, suggesting the meaningful interpretation of drawings in a specific manner other than graphically understanding, skills and abilities, based on the expected characteristics used or not used in the creation of an image.

The CaP overall high rate of success (as illustrated in Figure 7.21) suggests that the 4 axis star profile is a graphically element appropriate for use by students as young as 11 to 12 years old. Accuracy seems to be an area needing more focus and practice by the students. This is obvious as 2 out of the 3 CaP which scored 50% or less were relevant to this skill: ‘neatly label each axis’ (42%) and ‘connect points accurately’ (50%). Results would not be expected to be much different if a different sample of students were used for the studies. This is reflected through the results gathered for the star profile, amongst other studies conducted. The sample of work accepted for analysis and gathering of data reflects the true abilities of the student at the time of the completion of the work. Work which was completed to unsatisfactory levels was not analysed. It is accepted that the level of abilities in different schools/areas of the country etc. could differ for students of the same age. This would alter the results in Figure 7.22 which illustrated the overall rate of success per student, which was an interesting area for this study but definitely not a primary area of interest. Results (Figure 7.23) also illustrate that as the number of axis increases, so does its level of difficulty in creating it. The low rates of success relating to the use of more than 4 axis might be an indication that for the particular group of students, this is a challenging task. Such variations
in results would not have provided significant differences to the research questions of this study. It could, however, provide a significant difference in future research, if more specific and detailed areas on the use of graphicacy are pursued.

It is noteworthy that unexpected results similar to the ones discussed on star profile charts have not been identified during other studies of this research. This could be because the other elements of graphicacy covered had previously been discussed in various contexts by professionals and academics, forming part of the literature review preparation. No studies involving star profiles were reviewed for this work and thus there were no expectations of mistakes or difficulties students could potentially face. On the other hand, these kinds of results might be more common for graphicacy elements which combine graphicacy and numeracy. Another reason could be the amount of technical rules which are required to create the image. The more technical the image, the fewer variations or mistakes one would expect to come across during teaching and learning (Figure 8.3). Figure 8.3 illustrates this notion. The graphicacy elements with the highest technical complexities have very specific information delivery and fixed rules for its creation. As the graph moves towards less technically complex elements, the rules become more vague and general. Being a mathematical chart, the star profile has fixed technical rules of how it should be used. Perspective follows next in regards to the technical complexity which involves fixed rules about the angle of the lines according to the vanishing point(s).

![Figure 8.3 Level of technicality involved in each graphicacy element](image-url)

<table>
<thead>
<tr>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Star profile</strong></td>
<td><strong>Perspective drawing</strong></td>
</tr>
<tr>
<td>- Draw axes</td>
<td>- Identify a horizon</td>
</tr>
<tr>
<td>Using the same layout for each one (diving equally 360° into the amount of axes to be used)</td>
<td>- Identify vanishing point(s)</td>
</tr>
<tr>
<td>- Label axes</td>
<td>- Use of vertical lines to define the height</td>
</tr>
<tr>
<td>- Mark axes</td>
<td>- Use of vertical lines connecting to vanishing points to define width and length</td>
</tr>
<tr>
<td>- Number axes</td>
<td>- Identify the location of the facial features</td>
</tr>
<tr>
<td>- Use of a key for the numbering, colour use etc.</td>
<td>- Identify the size of each feature</td>
</tr>
<tr>
<td></td>
<td>- Draw the correct shape relative to the view</td>
</tr>
</tbody>
</table>

| **Portraits** | **Rendering** | **Logo design** |
| - Visible surfaces coloured in using the correct tone and gradient | - Shading should suggest the correct form/shape of the object | - Use of colours, fonts and graphic representations to represent the company, relate to the intended customers, communicate emotions, deliver a message. |
| - Shading drawn to suggest a specific material finish | - Add shadow to suggest the distance and height of light source and shape of object | - Draw the correct shape relative to the view |

Figure 8.3 Level of technicality involved in each graphicacy element
Depending on the context the image is used in, drawing in perspective can be used following the key rules of illustrating depth, height etc. either lightly or in a more strict manner. This would depend on the purpose of the image, i.e. if it is to be used as a technical engineering drawing or a free hand drawing or sketching. On the other hand, rendering follows key rules of how the light will be shown on different surfaced and forms, but these are often exaggerated to create a more dramatic effect. These rules are often used for simple forms such as cones, spheres and cubes. For more organic and ‘fluid’ forms, artists tend to depend more on experience and personal style rather than fixed rules. Rendering can be a very complex task, especially if other factors are incorporated such as the environment the object is in and any reflective surfaces. However, no surprising mistakes were identified during the analysis of students’ work on this area.

Portrait drawings are very similar to rendering in the sense that the starting point, when one is learning how to create these, can be very technical. To complete drawings depicting a face accurately, one has to practise in order to learn how to successfully create each facial feature as observed by the eye. Logo designing is the least technical graphicacy element studied in this work. It has numerous ‘rules’ of how colours, their combinations, forms, font etc. can be interpreted by different groups of people. It is heavily cultural dependent; and since culture is in constant ‘motion’/progression, these rules are open to change at any given moment.

8.2.1 Nature/ nurture

The above descriptions bring forward another important area to be investigated referring to stages/levels of graphicacy related abilities and their development that children aged 11 to 14 go through (RQ 9 and 10). Up until which point do CaP descriptors work/ are useful? If we believe that nature develops graphicacy skills up until around the age of 8 or 9, and then nurture is required for further development, CaP descriptors could be useful for KS3 and the beginning of KS4. The way these should be used needs further research, in order to identify if there is a certain sequence in learning these skills, or different levels of difficulty. But as seen above, this strategy will eventually fail, as the complexity of the technical level decreases; the CaP descriptors become less effective. Is the next stage do-able only through practice, observation and hands-on experience?

The CaP descriptors lists all show an increased level of difficulty. Six carefully designed classes and workshops provided data (Section 7.2) which support the arguments for nurture. This evidence was particularly strong during the rendering exercise (Figure 7.13), where students initially started colouring in the surface of the 3 dimensional objects as a flat surface. Only during and after the lesson did the students start colouring in the surface area in a way as to suggest certain 3 dimensional forms.
The CaP descriptor lists provided are not to be used as exhaustive or fixed models for teaching and/or assessment. They provide a description of a possible route of (interim) learning, as one is expected to have the potential to always continue learning. They are guidelines to help teachers fully understand the process of creating the image and the function and/or purpose of each stage/element of the image. This offers the opportunity to teachers to identify each stage/area of understanding one has to gain when learning how to create such elements of graphicacy for the first time. It is important to recognise that for each element of graphicacy there are many variations of a type of image which could be created to correctly illustrate information. The list can be used as a guide to plan a lesson which will have to be tailored according to the students’ abilities, prior knowledge and available resources, amongst others.

The CaP descriptors lists can also be used as a guide for the student during assessment and improvement of their work. Instead of saying to the student i.e. for a grade ‘A’ you have to correct the ratio of the facial features; you can use the CaP descriptor to go over the specific stages that need attention. If the student has tried his/her best to complete the work and has ‘mistakes’, it probably means that the student understands on those areas needs to be enhanced. Identifying the ‘mistake’ and asking for it be corrected without teaching the student on how to achieve that (perhaps repeating it yet again), will not help the student in understanding and learning the correct technique.

Once the technicalities of an element of graphicacy have been learned and the understanding of the purpose of it is gained, i.e. one has gained mastery in an element of graphicacy, the skills gained can be used or mixed with the personal style of the artist to start creating and/or designing. This is one way to start working towards the creation of innovative ideas and products/outcomes.

The CaP descriptors lists can also be used to help teachers across the curriculum get a better understanding of the fundamental importance of graphicacy. Often the skills and understanding involved in creating different elements of graphicacy are key in other areas as well, such as calculating distance, cost, and the value/worth/complexity. Another point was identified through the discussions with the teachers during the pilot study held at the Cypriot school. Once the different elements of graphicacy were pointed out and examples relevant to the teacher’s subject area were given, the teachers were surprised to realise the wide range of images they used. The identification of the cross-curricular links of graphicacy elements use would also be beneficial for teachers to know.

A number of case studies were completed for this research but not all have been reported in this thesis. This is because the data gathered either did not reflect the students’ true potential, abilities and understanding, or because the design of the lesson delivered did not
produce the desired results. One such study was designed for a Year 8 class (ages 12 to 13) focused on isometric drawing. According to Willats (1977) and Freeman (1980), children up to the age of seven tend to draw a square or a ‘fold-out’ version (Section 3.2, Figure 3.7), a configuration made up of a number of rectangles. The above authors do not specify when children start developing skills enabling them to draw 3-dimensional cubes. Arizpe & Styles (2003) collected evidence from children’s drawing which showed straight line objects drawn in oblique perspective by children around the age of 9 years old. This is also supported by this author’s prior professional experience. Most Year 7 students can draw simple shapes in oblique perspective and can learn how to draw simple cubes in isometric. A few students can draw more complex shapes using oblique technique, and the students considered as ‘gifted and talented’ in drawing can draw those shapes in isometric. However the Year 8 students, who took part in this study, were not able to complete simple cuboids in isometric, even with the use of isometric grid paper and step-by-step guidance. Figure 8.3 shows examples of 2 different students’ work. One example is taken from a Year 7 student’s work that had not been taught how to draw in 3-dimensional shapes either in the subject area of art or design and technology. The other example is from a Year 8 student during a step-by-step guidance lesson on isometric drawing part of a ‘failed’ case study conducted in 2010 by this author.

![Figure 8.3 Year 7 and Year 8 students’ drawings on 3-dimensional cuboids](image)

**8.2.2 Portrait drawings**

The methodology used for the portrait workshop was very successful. The difference between the task completed with no help (Task A) before the lesson and the task completed after the lesson (Task E) is very substantial. This was the case for both studies; the pilot study focused on adults and the case study focused on Year 7 students (Figure 8.2). This is a strong indication towards the validity of the results. It would be expected to have similar results, essentially independent of the sample group used in the study.
The two studies have also provided evidence towards nature and nurture in relation to drawing portraits. The results illustrated in Figure 8.4 are taken from the work completed by 2 female Year 7 students aged between 11 to 12 years old, and 2 male participants aged 22 and 27. The first unattended task completed by the students (and participants) before the lesson, seems to reflect a similar level for all participants, suggesting the level where nature stops developing the relevant graphicacy skills. All participants’ first drawing (except for one participant who was a secondary school art teacher) shared a great number of similarities in the way the facial characteristics were depicted, their forms and ratio in relation to each other i.e. the shape of the nose, the short forehead etc. It would be very unlikely for all students to have had the same kind of art lessons in primary education, and for all of them to have stopped the lessons at the same developmental stage. It is therefore reasonable to assume that the level of competency reflected through the first drawing, is the final developmental stage often attained through nature.

The evidence for the potential of nurture to enhance graphicacy capabilities is clearly visible through the drawing tasks illustrated in Figure 8.4, following the first unattended drawing.

Year 7 students’ work

<table>
<thead>
<tr>
<th>8A</th>
<th>8B</th>
<th>8C</th>
<th>8E</th>
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Unattended attended attended unattended

Adults’ work (aged 22+)

<table>
<thead>
<tr>
<th>9A</th>
<th>9B</th>
<th>9C</th>
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</table>

Unattended attended attended unattended
During the lesson (attended tasks), the quality of the drawings reached a lot higher levels from those attained on the first drawing. From being schematic, the drawings became pictorial and naturalistic representations. Both groups worked very hard during the studies, with very high concentration and persistence levels. During the pilot study the adults (participants) completed with full focus and attention 5 tasks more than the Year 7 students did: a naturalistic portrait looking from above ¾ turned away looking at it from the left hand side; looking from below ¾ turned towards the front looking at it from the right hand side; a front self-portrait; self-portrait turned into a cartoon; and a self-portrait turned into a caricature (Figure 8.5). These allowed the students to study the face from different angles. The Year 7 students’ levels of competency in conjunction with the long hours they had already spent working hard resulted in the decision by this author to skip the tasks relating to drawing portraits from an angle. Those drawings required much more concentration for long periods of time due to the sophistication and high level of competency required to understand the theory behind them. At that specific time of the day, that was considered to be unsuitable for that group of students. The adult participants also completed a self-portrait with attendance only when requested. Year 7 students were then taught how to turned general portrait drawings into cartoons and then caricatures. This part of the lesson was kept to a very ‘light’ and basic level as it was obvious that though excited and eager, the children were mentally very tired.

Figure 8.4 Evidence of nature and nurture
The final drawings illustrate students’ understanding and knowledge of the area. The adult students’ final drawing reached a higher level of competency than the Year 7 students did. This could be so for a number of reasons:

1. the adult students had a higher cognitive development;
2. the adult students were able to concentrate and learn for longer period;
3. the adults achieved a better understanding of the face and how to portrait that through drawing due 5 ‘extra’ tasks completed in the session;
4. the adults were working in a small group of 5 whereas the Year 7 students were part of an 18 student class.

However, there is no evidence so far to suggest that the Year 7 students could not reach the same level of competency as the adults achieved. It was clear through the lesson that it would take them longer to do so, but there was no indication suggesting the lack of key skills which would prevent them from reaching that level.
8.3 Continuity and progression descriptors

8.3.1 Methodology

Due to time restrictions, the students were not able to achieve their full potential on each task and therefore the potential offered by graphicy for the learning of all students has not been fully exploited (RQ 12). Their current level of competency on each area of graphicy was noted (RQ 9 and 10) which showed some of their abilities but that was based on a limited amount of tasks and exercises completed by the students on one day.

The ‘research within practice’ strategy (RQ 8) was successful in allowing for a record to be kept on students’ learning and progression and forming a logical criteria list of CaP descriptors.

The research results so far have allowed for detailed descriptors to be developed with regard to rendering, drawing using perspective, logo designing and portrait drawing which was one of the initial goals of this study.

The rate of success each descriptor received indicates its level of difficulty. The methodology, which was based on the collection of qualitative information, has allowed for pupils’ competencies to be recorded at different stages of their development. However, for a complete set of results covering the whole taxonomy, and in order to achieve a statistically significant sample this research will have to be conducted over a period of time while working with groups of pupils in order to record pupils’ full potentials and limitations across a range of year groups.

8.3.2 Strengths and Weaknesses

Each task piloted so far has proven the need to be treated as a different case. This means that no one fixed methodology can be planned and used for identifying and testing graphicy levels for the different types of images. However, this should not cause any consistency problems as the essential purpose of the main study was to identify what students could do at a certain age and draw CaP descriptors by analysing students’ work.

Some areas might need further investigation, as has proven the case with the symbolic representation case study. The CaP descriptors established from the first pilot study have been proven to be too general and vague in some instances; i.e. ‘use the correct colour to represent the company correctly’ and ‘use of appropriate colours to relate to the intended customers’. Additional work needs to be completed to enable these descriptors to be broken down further in a way to clearly articulate what is meant by ‘correct colour’, ‘represent the company correctly’ etc.
The analysis of the results potentially could allow the ranking of the CaP descriptors according to the level of difficulty, based on the percentage of success amongst the students. This was not an intended outcome for this research but a welcome addition to future expectations.

8.3.3 CaP descriptors
Continuity and progression descriptors are designed to help nurture graphicacy elements. They are designed as a procedural guide to learn the important stages in creating certain types of images. CaP descriptors seem to be a sound approach for KS3 to prepare students to successfully complete tasks within design and technology and art as well as in KS4 and beyond, where technical knowledge is required to be mixed with creativity (RQ 12). It is this author’s belief that once the understanding and knowledge of a graphicacy element or parts of it are gained, the ‘artist’ can skip a number of descriptors and/or incorporate a number of skills relevant to different elements to create a different outcome which can reflect an individual (personal) style. This is especially true for graphicacy elements which involve creativity, depending on the purpose of the final image.

Portrait drawings, for example, can be unique to the artist’s style, while clearly illustrating facial characteristics accurately. It is also commonly acceptable for portrait drawings not to be identical even if drawn by the same artist, using the same technique and illustrating the same person. CaP descriptors have been designed in a way to guide the student through the process of accurately drawing the guidelines to help the student fully understand the ratio between facial features, their position on the head and their general form. Once these are taught, individual style, further experience and practice will be required to fulfil most criteria required in KS4 and beyond. There are numerous ways for one to learn the ratios of the facial features, however, and it would be a reasonable expectation that some people who have never drawn portraits before to already know where the facial features are positioned on the head or their expected general size. Such people will not need to spend as much time learning and gaining an understanding of the guidelines taught by following the CaP descriptors. Further research could demonstrate if one can skip certain stages completely and still get a full understanding of the theory behind portrait drawings, sharing a theory with some academics about the developmental progression as described in Section 3.4 (Chapter 3).

When drawing graphs and charts such as the star profile, some of the stages as described in the CaP descriptor lists might be skipped, not because one can naturally pick them up but depending on the individual’s prior knowledge of similar graphs. For example, when labelling and marking out the axis, one who is used to creating graphs will know how to do that and what their functions are. If that knowledge has not been gained through nurture, results would
be expected to reflect work such as that shown by student (3) in Figure 8.2. When it comes to the final outcome, however, no imagination is expected to influence the outcome. The knowledge gained while working through the CaP descriptors is sufficient to allow one to use the particular star profile charts irrespective to the level of study. Charts are usually used as part of the language of international symbolic representations. This means that cultural or other trends should not influence the outcome when creating the 'traditional' star profile. This, and other charts and graphs, are expected to be more or less identical, independent of the person who created it. No further or different teaching and learning methodology would be expected to be required for KS4 or beyond regarding star profile graphs.

Unlike the more technical graphicacy elements such as charts and graphs, logo design is one of the most complicated elements to teach, or analyse or for which to establish CaP descriptors. The difficulty lies in 2 areas. Firstly, a logo design has to be unique in design. Most logo designs are patented exclusively to the company they represent. Secondly, the elements one has to study and learn and the combinations in which these can be used are endless. Each element can have one interpretation which can change the moment it is combined with another. Since the interpretations are culturally dependent, they constantly evolve. It would therefore be very difficult to document all the possibilities in order to teach the 'correct' way of using them in their numerous combinations. For example, the logo in Figure 8.6 does not look as if it represents a product or company which deals with cats, the animal, even though the printed name is CAT. The logo gives the ‘feel’ of a more industrialised product. This could be so because of the yellow colour often used as backgrounds for industrial signs, and the bold clean font used which gives the feeling of a ‘steady’, reliable and straightforward attitude.

![Figure 8.6 Logo design elements](image)

Furthermore, logo design seems to be one of the most difficult areas to create CaP descriptors for because it can rely heavily on creativity instead of technical skills alone. Creativity (and hence innovation) could cease to exist once the process of creating is ‘boxed’ within a set list of criteria. The CaP descriptors can be used as guides when learning competence in a particular area of graphicacy, but because of the complexity of the logo
design, they will not be sufficient in teaching and learning the skills required at higher levels. The skills required to successfully create logo designs depend to a great extent on personal style and experience. It would be surprising to get the same outcome (logo design) from different people while working on the same brief of creating a logo design for a specific client. This is due to the huge range of elements one can take into account when creating the logo including the designer’s expertise. Unlike the portrait drawings however, the artist will be expected to recreate an identical logo design over and over again. This is mostly due to the tools often used to create the final product which allows precision. CaP descriptors could, of course, be developed to teach how to use precision tools to get specific outcomes, as those can be technically based skills, but that is not the essence of logo design.

Perspective drawing and rendering both fall in a similar category. Once the theory is understood and learned using the CaP descriptors, the skills gained can be used to create a number of different graphicy elements. Perspective could be used in freehand sketching, paintings or technical diagrams. In the same way, rendering can be used as part of creative drawing, painting etc or for illustrating technical details in an accurate manner. The difference with rendering comes when dealing with more organic and ‘fluid’ forms. As with perspective, rendering is based on technical rules which can be used as guides to help a novice, in this area, to render 3 dimensional forms realistically. Unlike perspective, however, rendering can reach very sophisticated and high competency levels with the combination of organic shapes, multiple light sources, reflective surfaces and the surrounding environment. It has not been established how the transition can be made from learning how to render simple cuboids to dealing with more complicated renderings.

CaP descriptors can be used to teach the rendering of simple geometrical shapes. To make the transition towards more complicated rendering, such as dealing with organic shapes, 2 possible routes can be identified. The first way is very technical and depends on learning how to calculate angles of the light and how that would be reflected off different angled surfaces (in the same way CAD programmes work). This could be taught using CaP descriptors but it would be a very time consuming and complicated way of dealing with very complex forms and surfaces. The second way would depend on practice and observational drawings, where one develops the ability to understand if something looks correct. This means that personal style and experience will be required and be involved when creating drawings and paintings. This requires cognitive abilities, and modelling within the ‘mind’s eye’. While developing these required skills of rendering within the mind’s eye, a move upon a hierarchical list of competencies is required. Figure 8.7 illustrates the human capabilities and a hierarchy of competences in the context of designing, as described by Norman (2011). Modelling within the mind’s eye requires skills such as numeracy and graphicy. Breaking these down further into competencies, they could include knowledge and understanding of graphicy elements such as rendering and perceptive drawings. Breaking these down further into emerging
competencies could include spatial understanding, mark making and personal style, amongst others. The level of individuality and personal style involved in the design of an image will be reduced depending on how technical the diagram or drawing is required to be. As with teaching and learning logo designs, a different (teaching and learning) methodology will have to be adopted for higher levels.

Figure 8.7 Human capabilities and a hierarchy of competences in the context of designing (Norman, 2011)
8.4 Collaborations

As mentioned before, there is a wide range of different variations in images each graphically element covers. This research has been focused on a small percentage of the existing graphically elements available. This notion is illustrated in Figure 8.8. The red balloons illustrate the elements of graphically studied in this research, against the map of all the potential elements of graphically available and used currently within education. It would be unrealistic to expect one researcher to analyse all, or even a large percentage of those images in order to create CaP descriptors, in a short time frame. The aim of this research is to help teachers and educationalists understand the importance of graphically and what it takes for that to be taught successfully. In order for that to be achieved and be helpful for current practices, a number of graphically elements will have to be researched and analysed. Because of the vast amount of work required in this field, a number of collaboration methods were sought. Co-research was one of the collaboration methods tested for this research.

Figure 8.8 The concept of graphically elements cover by this research illustrated

8.4.1 Co-research

The essential target of the explanation of co-research was to explore strategies whereby appropriate data gathering could be pursued (RQ 13). The success of the research within practice strategies opened up the potential of extending this approach. PGCE students are encouraged to pursue research at M-level, and the encouragement of practitioner research has been a long-standing policy target in England (at least). If strategies that were not too time-consuming could be established, then perhaps this could support such endeavour.
The results gathered through co-research with the PGCE students marked the beginning of testing the idea of this methodology. The results gathered through this method relating to graphicacy did not add new data to this author's work relating to CaP descriptors. The continuity and progression descriptors established through co-research were more specific than any graphicacy levels found in the design and technology National Curriculum of England, but were not broken down enough to provide clear CaP descriptors of the tasks, i.e. ‘Understand what logos are and why they are used’. Four students chose initially to complete their course assignment focused on graphicacy. Two students ‘dropped out’ because of problems with their placement i.e. they had been allocated to a ‘challenging’ school and did not have adequate support from their mentors. Another student from the group tried to work on this project but it was obvious through the material he was developing and the discussions held that he did not manage to comprehend the concept of graphicacy or the aim of the research. One student was able to follow and complete the assignment based on graphicacy. The student was very conscientious and quickly gained a strong comprehension of what graphicacy is and the aspects and perspective this author was working on. She was also confident in designing and preparing lesson plans and relevant resources. It was hence safe to assume that she was a good candidate with whom to test the concept of co-research. Through our collaboration, the PGCE student came across a book designed to prepare GCSE students to take the AEB test. Even though the book did not reveal any new information, this was a new resource to this author. The student appeared to have the potential to complete research to very high standards and collect reliable and valuable data. A number of reasons were responsible for the quality of data she gathered:

- The time restrictions placed on this assignment;
- The heavily loaded schedule she had to cope with as a PGCE student;
- She was a novice teacher;
- She too was allocated in a ‘challenging school’;
- The above resulted in gathering data from a very small sample of students i.e. 2 or 4.

Through discussions and email exchange with professional teachers and educators during and after conferences, it was clear that many teachers already have knowledge of CaP descriptors and often use them during teaching and assessment. These are, however, very rarely articulated. This offered an indication that co-research has the potential to be useful and successful if more time can be dedicated to setting it up and participants have more time to enable their involvement.

Experienced teachers would be better suited for such research as PGCE students have much to deal with in a very short time, i.e. learn how to control and guide the class, gain confidence, make suitable changes during the lesson to suit the group of students etc. and complete University assignments. The task set through co-research has been proven to be challenging and quite difficult for new teachers. The PGCE student did complete research...
following the correct methodology by using the information given by the main researcher. Perhaps that is indicating that co-research has better potential of success if it is focused on quantitative information rather than qualitative, as such data are easier to analyse by novice researchers.

Co-research would be beneficial especially if it could be designed to run on a large scale i.e. by 100s of teachers in England or even 1000s worldwide. In order to successfully complete co-research, it will have to be designed to run in a 'controlled' way initially. An online website would be ideal, allowing teachers to be involved from the comfort of their classrooms or homes. A website can be set up with examples of CaP descriptors for certain elements of graphicacy, broken down as much as possible with students’ work illustrating each descriptor. Teachers can be trained either in person on through e-learning on how to complete research, document and analyse work using the website. Assessment of students’ work can then be completed online by ticking the boxes of the relevant CaP descriptors of which the students’ work demonstrates completion. When submitting (saving) the information on the website, a printed version could be provided as feedback for the student. This would save the teacher time as they will not have to write repeatedly (often) the same points each student needs to address to improve the work. It will also provide a record of progression (for each student) over a period of time; data which can also be used by researchers since it will be documented online. Teachers can also be given the opportunity to add descriptors of CaP and scan-in students’ work to illustrate these in order to enhance an existing list. These would be submitted and reviewed by the panel director(s), and if thought to be correct would then be uploaded and added to the lists provided online. Teachers could also have the option to start creating CaP descriptors’ lists on new (to the research) elements of graphicacy, which could be checked before being published online in the same way. This method could minimise the time teachers are required to spend on research, and would also help with the reliability of the data gathered. Once this system was set up and tested, there would be major research potential.
CHAPTER NINE

Conclusions and future work

Introduction of Chapter 9
The conclusions drawn from this research are presented, contributions to knowledge stated and recommendations for future work made.
9.1 Conclusions

In relation of the overall aim of the thesis (To map graphicacy across the English secondary school curriculum, understand its purposes and its effects on students' learning), a taxonomy has been developed as a research tool which maps graphicacy across the English secondary school curriculum. This has been validated through a Delphi group study and through empirical research across three schools in 3 different counties (Cyprus, UK and the USA). The taxonomy has been used as a research tool to identify links between graphicacy use in different subject areas and cross curricular links.

The cross curricular survey has revealed several teaching purposes for graphicacy, amongst which were; to support embedding new knowledge; spark conversation and illustrate students' ideas, knowledge, and understanding. Subsequent empirical research focused on students' outgoing graphicacy skills which were; perspective, rendering, star profile, portraits and symbolic representations. It was shown that appropriately developed tasks allowed students graphicacy skills to be developed within short time periods and the potential for a cross curricular strategy for graphicacy which linked such common graphicacy requirements was evident. Such a strategy would enable students to progress both in graphicacy and in related areas of learning across the curriculum.

The initial aim of this research is divided into 3 objectives which include mapping graphicacy across the curriculum, understanding its purposes and their effect on student’s learning. The conclusions on what has been established through this research are listed below broken down according to the initial research questions under each objective. The research conducted for this thesis has still images as its focus, rather than moving or interactive images.

Research objective 1: ‘Establish what graphicacy is and how it is used in the school curriculum’.

1. What is graphicacy?

Graphicacy has been defined in this thesis as the ability to communicate and convey information through still images. Graphicacy covers the entire range of still images (used in education) as identified through the research based on the analysis of textbooks across the curriculum in 3 schools, one in each of: Cyprus, the USA and England. These are divided into the following categories as derived from the literature review:
• Pictorial: Western Art (life drawing, landscape, still life, portraits, other compositions), Drawing (drafts, sketching, drawing), Diagrams (perspective, architecture, engineering/technical, exploded, projections);
• Sequential: story boards, flow diagrams, spider diagrams/brainstorming;
• Symbolic: quantitative/abstract (charts & graphs, symbols), spatial/qualitative (maps, advertising media);
• Photographic: photographs
• Computer aided design: computer aided images, computer generated images;
• Other: puzzles, crosswords, games etc.

There are two directions of information flow when dealing with graphicacy. Reading and understanding information (inbound/incoming skills), and creating images to convey information (outbound/outgoing skills).

2. Has graphicacy across the curriculum been studied before? If so, what were the findings?

Literature review identified work completed on graphicacy in a number of countries, across different subject areas and by a number of different authors.

• In the UK, graphicacy was studied between the 1960s and 1980s. The main focus lay within the subject area of geography. In the USA, Fry (1974:383) supported the notion of ‘literacy in graphs which was beginning to approach word literacy’. Research following similar beliefs was also conducted in the 1990s and the beginning of 2000. In South Africa, Wilmot followed the work of UK authors from a geography perspective (in the 1990s). Her work was focused on graphicacy and young children, and resulted in incorporating graphicacy within the South African Primary National Curriculum. In the 1980s, the Senate Standing Committee on Education and the Arts in Australia conducted work on the importance of graphicacy as fundamental aspects of education and social life. In Ireland, Seery reviewed graphicacy within education related practices and its evolution during the 20th century. However, the studies identified through the literature are mostly isolated, independent studies instead of a unified effort to demonstrate the importance of graphicacy.

• An existing taxonomy of still visual images (referred to by the author, Fry (1981), as graphs) for curriculum use was identified. A number of other different taxonomies have been identified for educational research; with a range of different taxonomic dimensions i.e. the representation, the message, relation/correspondence, task and process, context and convention and mental representation. These have been used for a range of different purposes relating to graphicacy, such as analysing the use of graphicacy within different subject areas (e.g. geography or mathematics) but not for cross-curricular analysis.
3. How can we measure graphicacy?

Different methodologies have been identified for measuring graphicacy. Literature review has discussed existing practices, and through the primary research, different methodologies have been designed, tested and implemented.

- Progression in children’s drawing capabilities for ages 1 to 8, has been identified through the analysis of their drawings (e.g. Kellogg).
- Research for this thesis has shown that graphicacy CaP descriptors can be identified through the completion of tasks and exercises.
- Research within practice has proven that well designed tasks can be produced to provide formative assessment of children’s understanding and knowledge before a lesson, during and after a lesson.

Summative assessment of graphicacy capability would depend on statistical analysis of large samples of students’ work. The research of this thesis has been focused on qualitative research and the formative assessment of students’ work.

- Continuity and progression descriptors can be established through analysis of students’ work. These were established for specific techniques relating to: perspective drawing, rendering, logo design, portrait drawings, and star profile charts.
- The difficulty of establishing continuity and progression descriptors lists was found to be related to the technical complexity of the particular element of graphicacy.
- Continuity and progression descriptors lists can provide a tool for sound assessment for learning, providing evidence of progression through tasks as described above. Evidence suggests the CaP descriptors can be useful for young children aged 11-14 as well as adults aged 20-28.
- Co-research might provide the means for completing a statistical study which could establish levels of achievement in graphicacy capability and provide summative assessment.

4. Are there existing ‘graphicacy tests’ or tests based on the skills of creating images?

Through the literature review, graphicacy tests have been identified and reviewed. This included the following.

- One graphicacy test (the AEB test) which tests various elements of graphicacy, focusing on inbound and outbound graphicacy skills.
- A number of tests and exercises have been identified, which focus on reading and/or creating maps and graphs (and charts).
• Other tests of graphicacy (e.g. Wilmot’s tests) measured some graphicacy elements in conjunction with other skills and abilities, such as cognitive modelling, teamwork, and organisational thinking.

Research objective 2: ‘Demonstrate the wider significance of design & technology teaching and learning by collecting evidence of the importance of graphicacy across the curriculum’.

5. Where does graphicacy fit across the curriculum?

Graphicacy is linked across all subject areas for KS3, KS4 and KS5 levels as indicated by the research based on the analysis of textbooks. Design and technology textbooks used in the UK school which took part in this study used the widest range of graphicacy images. Art textbooks used in Cyprus and the USA used the least variety of graphicacy elements. The wider range of graphicacy elements use within the textbooks analysed is listed in a hierarchical order with the highest at the top according to the relevant subject areas:

1. England: DT;
2. England: science;
3. Cyprus: DT;
4. Cyprus: languages, biology, RE; USA: calculus; England: mathematics;
5. Cyprus: history; USA: languages;
6. Cyprus: chemistry; USA: history; England: geography;
8. USA: chemistry; England: French (foreign languages)
9. Cyprus: physics, music, Greek language; USA: geometry; UK: English language
10. Cyprus: art;
11. USA: art.

• In the English and Cypriot schools, all subject areas studied had graphicacy links with design and technology at KS3 (design and technology was not studied in the USA).

6. How does graphicacy appear in ‘teaching’ (within the sample of schools and subjects studied)?

Literature review identified strong connections between graphicacy use and the subject areas of mathematics and geography.
• Extensive research has been completed on graphs and charts, maps and cartography use and associated reading skills within education.
• All elements of graphicacy identified in the taxonomy of graphicacy were used in the textbooks analysed. The following list places in a hierarchical order the most commonly used elements of graphicacy in the textbooks analysed across the curriculum, within the 3 schools starting with the most common:
  Photographs; charts and graphs; storyboards; symbols; drawings, spider diagrams, maps; perspective/projections; flow diagrams; other; art; engineering/technical; advertisement, 3D; CAD; sketching; architectural; cartoons; landscape, still life; life drawing; drafts.
• The use of graphicacy elements during teaching relates to the teacher’s attitude towards the contribution images can make.

7. What are the main similarities of the use of images across different subjects?

From the pictorial, sequential, symbolic, and CAD categories of the taxonomy, the following teaching purposes emerged for the use of such images:

• Gain familiarity and place new knowledge into context;
• support embedding new knowledge;
• provoke interest;
• spark conversation;
• illustrate students’ ideas, knowledge, and understanding;
• visual stimulation;
• visual representation of information/data;
• test students’ knowledge;
• test students’ understanding; and
• explore research, and understanding.

From the additional category which emerged from the pilot study entitled “Other”, the following two teaching purposes emerged for the use of such images:
• organize information; and
• learn through play.

These teaching purposes are in line with earlier findings from the literature, on images and teaching based on research into more specific aspects of pedagogy.
Research objective 3: ‘Establish how the abilities to understand and create images affect students’ learning’.

8. Are there established methods for studying graphicy within the curriculum?

A number of authors’ work on studying graphicy within the curriculum has been identified through the literature review.

- Fry’s taxonomy of graphs was created in the 1970s, in order to taxonomise graphs (images) according to their type. The taxonomy was not designed to undertake cross-curricular research. A new taxonomy has been created based on updating and extending Fry’s taxonomy.

- This new taxonomy of graphicy has been established through this research and the Delphi study as a valid instrument for analysing graphicy use across the curriculum through analysis of textbooks.

- Although graphicy tests have been conducted for measuring graphicy elements within certain subject areas, i.e. mathematics and geography, no established methodology has been created for measuring graphicy within the curriculum.

- The research within practice has established that lessons and tasks can be created to collect student’s work, analyse it and create continuity and progression descriptors. These have been used to study some elements of graphicy within the curriculum effectively.

9. Are there main stages/levels of drawing, mark making or other graphicy related abilities that children go through?

A number of researchers have conducted research on developmental stages of children’s drawings.

- The different perspectives work has been focused on so far are reflected through the work of Kellogg, Lowenfeld and Gaitskell. All three perspectives show a similar pattern of development and indicate stages/levels of drawing stages/abilities. These are mainly focused on children aged 1 to 13. Some author’s work is less detailed than others, i.e. Lowenfeld’s in comparison to Kellogg’s work.

- This research has not been focused on the investigation of stages/levels of drawings that children go through. However, it has established that Year 7 students have the mental ability to learn oblique perspective drawing of straight lined objects. This could indicate that children can develop that graphicy skill naturally. It could also suggest that children have the mental ability to learn how to draw 3 dimensional objects in oblique with no individual help; influenced by images and forms illustrated in 2 dimensional media around them.
10. How does graphicacy capability change/develop during the years of 11-14 years?

Very little is known on children's graphicacy capabilities and how these change or develop during the years of 11 to 14.

- The literature reviews provided very vague descriptions of how children’s art might be influenced or change during years 11 to 16 and beyond (i.e. Lowenfeld).
- This research has provided evidence to show that the Year 8 students involved in this study did not reach an understanding of perspective drawing. This could suggest the students did not have the mental ability to understand that concept.
- Similarly, through the case studies, it was evident that the Year 8 students did not naturally possess the required graphicacy skills to create cuboids in isometric.
- Through the workshop, it was established that Year 11 students were able to draw 3 dimensional cubes, mostly using the oblique projection, prior to the lesson.
- Through the same study, it was established that all Year 11 students were able to draw cubes in isometric projection.
- Through the same study, it was established that all Year 11 students were able to draw cubes using 1 and 2 point perspective.

11. How fundamental is graphicacy to students’ progress?

The cross-curricular links identified through this research provide an initial indication as to how fundamental graphicacy can potentially be to students’ progress. Further future research is required for more specific answers in this area.

12. Is the potential offered by graphicacy fully exploited for the learning of all students?

The literature review, the results of this study and the recommendations for future work are evidence of the lack of information and research conducted so far on how graphicacy affects students' learning.

13. Can co-research provide useful data for this research?

Through the studies completed on co-research with PGCE students from Sheffield Hallam University, the following conclusions can be drawn.

- Co-research is challenging and quite difficult for new teachers;
• The results obtained by the PGCE students did not offer significant additions to the starting position provided by this author;

• When undertaking co-research with PGCE students, although they followed the methodology correctly, they were not really advancing much further than the national curriculum statement;

• This suggests that setting up such research nationally or worldwide would not provide a useful outcome;

• However, the outcome might be different with more experienced teachers.
9.2 Contribution to knowledge

The contribution to knowledge made by this thesis includes:

- The drawing together of prior research relating to graphicacy;
- The creation and application of a new taxonomy of graphicacy suitable for cross-curricular analysis;
- The establishment of strategies for research within practice which are capable of generating continuity and progression descriptors for elements of graphicacy;
- The investigation of limiting factors in co-research that could enable a major quantitative investigation.

These contributions have enabled the research objectives to be met and are described in more detail below.

An extensive literature review was conducted connecting a number of studies of graphicacy which have been created in different countries over a long period of time. This developed an understanding:

- of what graphicacy is, the meaning of graphicacy, elements related to it and relevant studies conducted in the past including: related studies in different subject areas related to, spatial abilities, advantages and disadvantages of image use within teaching; graphicacy in relation to literacy and the concept of multiple intelligences;
- of existing work on a range of stages and levels of drawing and developmental stages that children go through between the ages of 1 to 16 and beyond;
- related to how children respond to images, gender differences, nature versus nurture debates and exercises believed to enhance graphicacy;
- of existing methodology used to measure graphicacy or elements of it through tests and how these are mapped to reflect levels of different abilities and competencies.

A new taxonomy of graphicacy was created and used as a research tool during the primary research.

- A taxonomy of graphicacy was established and verified by a Delphi study as a valid instrument for analysing graphicacy use across the curriculum through analysis of textbooks.
- The taxonomy was used during analysis of textbooks across the curriculum in three schools, one in each of: Cyprus, England and the USA. Graphicacy use across the curriculum has been mapped. Similar patterns of graphicacy use were found across the 3 schools. The same teaching purposes relating to the images used across the curriculum were identified across the 3 schools.
The wide significance of design and technology's teaching and learning has been demonstrated, based on evidence of the cross-curricular links identified on the use of graphicacy.

Mathematics, geography and science use a wide variety of graphicacy elements in the textbooks analysed across the 3 countries.

Photographs, charts and graphs, storyboards and symbols are the most commonly used elements of graphicacy across the curriculum, within the textbooks analysed across the 3 countries.

Teacher's attitudes towards graphicacy elements have a great impact onto the use of images during teaching.

The research within practice has established the following:

- Lessons and tasks can be created to collect student's work and analyse it.
- The results obtained from the analysis can be used to create continuity and progression descriptors.
- Continuity and progression descriptor lists have been created for specific techniques used to teach the following: rendering technique, perspective drawings, logo designing, portrait drawing and star profile graphs.
- The difficulty of establishing continuity and progression descriptors lists is related to the technical complexity of the particular element of graphicacy.
- Through nurture, skills and abilities related to the graphicacy elements studied in the primary research can be further developed.
- Evidence has been collected identifying the stage were nature stops developing graphicacy skills in relation to portrait drawing skills and abilities.
- The continuity and progression descriptors can be used for identifying progression of knowledge and understanding and formative assessment.
- Continuity and progression descriptor lists can be used by people learning to create a certain type of image, aged 11 and beyond.
- Year 7 students have the mental ability to learn oblique projection drawing of straight-lined objects.
- Year 8 students do not naturally possess the required graphicacy skills to create cuboids in isometric.
- Year 11 students have the mental capacity to learn how to draw 3 dimensional cubes using oblique and isometric techniques and by using 1 and 2 point perspective.
The investigation into co-research as a methodology has established the following:

- Co-research might provide the means for completing a statistical study which could establish levels of achievement in graphically capability and provide summative assessment.
- Co-research is challenging and quite difficult for new teachers.
- The results obtained by the PGCE students did not offer significant additions to the starting position provided by this author.
- When undertaking co-research with PGCE students, although they followed the methodology correctly, they did not advance much further than the National Curriculum statements.
- This suggests that setting up such research nationally or worldwide would not provide a useful outcome.


### 9.3 Future research

**Continuity and progression descriptors**

The research so far has established a methodology that has proven to be successful in developing CaP descriptors. Further research could be completed based on the methodology developed; covering the entire area that CaP descriptors can cover relating to specific graphicacy elements. By doing so, the point or level at which CaP descriptors cease to be a useful strategy can be recognised, and the point where a different teaching and learning methodology required will be identified.

**Action research**

Another area for potential future research could involve graphicacy audits through the use of action co-research targeted on improving curriculum strategies concerning graphicacy. It has been established that graphicacy is widely used across the curriculum and through the results of this research it is evident that graphicacy strategies do not exist at the moment. Once the taxonomic classification of level descriptors is complete, action research will be possible. The agreed target with the schools involved could be ‘to improve curriculum strategies concerning graphicacy’. A strategy would have to be agreed on and implemented before collecting, analysing and evaluating the outcomes. Teacher workshops could then be run to add in more detail and better quality of assessment for and of learning. Then the loop can be repeated again by agreeing on a new target to be implemented and evaluated (Figure 9.1).

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**Figure 9.1 Action research**
Co-research
Potential and limitations of co-research have been studied in this research. New methodologies and strategies can be developed and tested in order to establish successful strategies for co-research. Through discussions with academics and teachers during conferences and the Delphi study group, a potential methodology (yet to be tested) appeared possible. Experienced teachers could have tacit knowledge of pedagogy concerning graphicy which could be articulated. This involves the creation of a website where people can use the existing CaP descriptor lists; add examples of student's work, CaP descriptors and/or other observations. This could facilitate co-research at national and/or international level.

In addition, other possible strategies for co-research with academics and educationalists can be investigated.

Graphicacy pedagogy
The CaP descriptors are a pedagogy developed to aid in teaching and learning certain graphicacy elements. These need to be tested further, to establish greater understanding to ensure their correct and effective use:

- How does appropriate pedagogy change with age?
- How does appropriate pedagogy change according to the increasing complexity and/or technicality in dealing with the graphicacy concepts?
- Would the above results be the same for all areas of graphicacy?

Potential and limitations according to age range
A number of areas can become the focus for future research, relating to the potential and limitations of graphicacy skills according to age range.

- Identify the true potential and limitations of children and identify how these relate to age.
- Establishing the extent to which the environment or culture affect the graphicacy inbound development and skills i.e. how would children’s’ graphicacy differ at certain (young) ages in a busy metropolitan city, in a rural village and in an isolated community.

Graphicacy skills related to other abilities
A number of tests have been discussed, which use graphicacy to measure intelligence, mental or psychological levels. Future research could be focused on collecting empirical evidence towards and/or against such ideas. These can be focused on:
• Relating graphicacy levels to numeracy and/or literacy levels. Can graphicacy level at one age reflect an expected level of competency in numeracy/literacy in later years?
• Could graphicacy levels identify the more able/gifted students in certain areas?
• How does the learning of graphicacy elements in one subject area affect students’ learning in another subject area?

Cross-curricular graphicacy use
An unexpected outcome of the cross-curricular analysis of textbooks was the pattern which emerged for the use of graphicacy across the curriculum within the 3 schools. Further investigation on those similarities can be pursued to identify:
• How the pattern of graphicacy use relates to different textbooks used by other schools in England and USA? (in Cyprus the same textbooks are used by all schools).
• Can these patterns be found by analysing textbooks in other European countries?
• How would those relate to the image use within textbooks in Asia?
• Are there specific purposes some images are used for? Are these subject-specific? Are they culturally dependant?
References, Appendices and Annexes
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List of publications


APPENDICES

Appendix 1.1

1. Presentations, 2008 - 2011

A number of presentations were made during the course of this research in order to gain feedback and validate the findings to that stage. These, are described in the following section.

Design Advanced Research Training (DART) conference

This presentation reported on the literature review findings of ‘what is graphicacy’. A new taxonomy of graphicacy developed by this author as a research tool was presented and discussed.
(Relating to research question 1)

Design & Technology Association conference

Graphicacy as a basic communication skill was discussed with supporting evidence from literature and research. Graphicacy was mapped across the curriculum and a case was made for its importance within the curriculum.
(Relating to research questions 1, 2 & 5)


The presentation was primarily focused on the pilot study and case study conducted in a school in Cyprus and USA, mapping graphicacy across the curriculum. Background information drawn from literature review and the new taxonomy of graphicacy were also presented and discussed.
(Relating to research questions 1, 2, 5, 6 & 7)

1st International Visual Methods conference
Presentation: ‘The development of graphicacy in humans’, Leeds University, September 2009

The workshop commenced with an introduction to graphicacy and its development in humans. Its development in young children and its relationship to cognitive development according to literature review was then reported. Prior research concerning the; importance of graphicacy in education, the significance of graphicacy in the presentation of quantitative information in an educational context and the emerging research agendas associated with
computer generated images were described. Future research plans were outlined and discussed.
(Relating to research questions 1, 2, 5, 6, 8 & 9)

**Loughborough University Teacher Mentors workshop**

This session was used as an introduction to the idea of graphicacy, its importance within school curricula and especially within D&T. Mentors were briefed on the aim and objectives of this research and were encouraged to take part or motivate the trainee teachers they were mentoring to take part as co-researchers.
(Relating to research questions 1, 2, 5, 6, 7 & 12)

**Loughborough PGCE students workshop**

This workshop was designed to illustrate the concept of modelling to PGCE students through tasks and activities. An input on graphicacy was also presented, explaining the concept of what graphicacy is, why it is worth looking into and how we can use this area for further research. PGCE students are required/ encouraged to undertake action research as part of their studies, and this workshop was aimed at developing students’ understanding of some of the different areas they were asked to complete action research in.
(Relating to research questions 1, 2, 5, 7 & 12)

**Sheffield Hallam University 2010**

The workshop was used as an introduction to the PGCE students into action research and to the idea of co-research. An example of research was given to the students along with a detailed plan on how to plan, follow through, analyse and report back on research. The meaning of graphicacy was described and the taxonomy for graphicacy analysed and discusses. The development of graphicacy in humans was introduced and the lack of information in this area pointed out. Graphicacy in the DT curriculum was identified and discusses and previously conducted case studies on this area analysed. Methodology and data collecting technique were discussed. This formed the first workshop for co-research between this author and PGCE students.
(Relating to research questions 1, 2, 5, 6, 7, 8, 9 & 12)

**Design & Technology Association conference**

The aim of this workshop was to introduce the idea of co-research, report on the first trial previously conducted and discuss limitation and potentials. The taxonomy of graphicacy was introduced as a research tool. All delegates were asked to form small groups and try to place images taken from the Cypriot DT curriculum within the correct categories. This was an example of co-research, demonstrating some of the difficulties in using a pre-designed methodology which formed the basis for discussion. The methodology used with the PGCE students from Sheffield Hallam University was described by one of the PGCE participants from the point of view of a student who had experienced co-research. This author concluded the workshop with the concept of co-research in a grater scale, amongst secondary school teachers within the entire of UK, or even perhaps, Europe.
(Relating to research questions 1, 5 & 12)
**International Visual Literacy Association conference**


Three case studies were conducted in the USA, Cyprus and UK identifying where, how and why images are used across curricula. The methodology, application and implementation of these are described and the results are analysed and reported. The development of the taxonomy of graphicy used as a research tool is described and the results from the comparative studies discussed. Similar patterns of usage and purposes found are discussed. (Relating to research questions 1, 2, 5, 6 & 7)


The ‘Quick on the Draw’ exhibition by Ken Baynes was developed into a digital exhibition and was introduced during this presentation. The concept of the exhibition was explained and a symposium on the importance of graphicacy for people from all walks of life was raised. (Relating to research questions 1 & 5)

**Cyprus Ministry of Education**

Presentation: ‘Identifying continuity and progression in the development of graphicacy’, A technological dimension of general education as a necessary element, October 2010

The presentation was aimed at the ministry of education of Cyprus, the design and technology inspectors of pre-schools, primary and secondary schools and teachers. The presentation was focused on identifying graphicacy and its importance in our everyday work life, and the lack of information we have so far on its progression and development for secondary school children. Case studies results were discussed of cross-curricula graphicacy links and examples of tasks created to obtain continuity and progression levels were presented. A case was brought forward to illuminate the audience of the importance of graphicacy and how it could be incorporated into the existing Cypriot national curriculum of design and technology. (Relating to research questions 1, 2, 3, 5, 6, 7, 8 & 9)

**International Design And Technology Educational Research (iDater online) conference**


The development of graphicacy capability was described for ages 0 – 15. Gaps within the existing knowledge found within the literature were identified and relationships with current research were made. (Relating to research questions 1, 8 & 9)


The methodology strategy developed for the research on identifying graphicacy continuity and progression levels is presented and analysed. (Relating to research questions 1 & 12)

**Sheffield Hallam University, 2011**


The workshop was used as an introduction to the PGCE students into research, with a main focus but not limited on graphicacy and to the idea of co-research. Examples of individual and co-research was given to the students along with a detailed plan on how to plan, follow
through, analyse and report back on research. The meaning of graphicacy was described and the taxonomy for graphicacy analysed and discusses. The meaning of co-research was given and described through examples of previous use and a task was given focused on using an already established research tool by a number of individual researchers. Graphicacy across the curriculum was identified and discussed and previously conducted action research on this area analysed. The importance of DT as a subject area was discussed and arguments on skills taught in the subject which go beyond preparing students to be designers were given. Methodology and data collecting technique were discussed. This formed the first workshop for co-research between this author and PGCE students.
(Relating to research questions 1, 2, 6, 7 & 12)
Appendix 2.1

Existing tests based on children’s art

Human Figure Drawings Test by Koppitz

Context: After 1940 a renewed interest started in children’s drawings and personality studies, known as the projective method, which brought a new dimension to Human Figure Drawings (HFD).

Approach: It was believed that child’s drawing and painting characteristics reflect their personality, habits and behaviours. Koppitz (1968) used HFD approaches to identify emotional disorders in children and suggested alternative ideas in the interpretation of special signs.

Implementation: A single drawing request from each child is accepted for this test.

Methodology: The methodology was developed by examining 1,856 human figure drawings from children between the ages of 5 to 12 which resulted in 30 developmental items ‘derived from the Goodenough-Harris scoring system and from the writer’s own experience (Koppitz 1868:9).

Assessment approach: Each child is requested to ‘draw a whole person (Koppitz 1968:6) but no spontaneous drawings of the human figure can be used for this test. The 30 developmental items are grouped at each age level in four categories (Koppitz 1968). In addition to the 30 developmental items Koppitz lists various emotional indicators. These include the absence of eyes, mouth, arms, legs, hands, feet or neck; a figure height of nine inches or more; a height of less than two inches; a slant of more than fifteen degrees from the perpendicular, very long arms, very short arms, and added clouds, rain, snow or flying birds. Some of the meanings assigned to the presence or absence of certain line formations include: shading the face indicated discontent with oneself, and shading the body reveals body anxiety (Koppitz, 1968:57). In general terms, the part of the body that is drawn in an unexpected way or somehow stands out (by not being drawn, drawn too big, shaded etc) represents a feeling, emotion or thought of the child.

The Bender Motor Gestalt test

Context: The fact that basic intelligence increases with age and that this intelligence can be measured by the ability to copy certain Gestalts is assumed here. This is a theory contrary to Gardner’s ‘multiple intelligences’ theory which suggests that there are a number of different intelligences such as spatial, body-kinesthetic intelligences etc. According to Gardner, the development of one intelligence does not necessarily affect or influence the development of another.

Approach: The Bender Motor Gestalt Test is a psychological assessment instrument. It relies on the idea that when one looks at an object he/she sees spots and light reflections which are transmitted from the eyes to the brain to be translated into the object ‘seen’.

Assessment approach: The Bender Gestalt Test is used to evaluate visual maturity, visual motor integration skills, style of responding, and reaction to frustration, ability to correct mistakes, planning and organizational skills, and motivation. The rational of this test lies in the fact that copying figures requires fine motor skills, the ability to discriminate between
visual stimuli, the capacity to integrate visual skills with motor skills, and the ability to shift attention from the original design to what is being drawn.

The Easel Age scale test

Context: Lantz (1955:10) commented that the reliability and validity of this test has been ‘satisfactory correlated’ with the Goodenough test and other tests. It is noteworthy that ‘special effort has been made to avoid turning the Easel Age scale into a measure of artistic ability’.

Approach: The test is focused on identifying mentally retarded children by their age by analysing one painting created by the child. According to Lantz (1955:14) abstract paintings are not used for the Easel Age scale test, but are held suspect and are described as ‘primarily an expression of emotions rather than ideas’.

Implementation: One painting per child is accepted.

Methodology: The Easel Age scale test was based on a study of 3,000 easel paintings of children aged 4 to 9 years old and had been under development for ten years, when it was first published in 1955.

Assessment approach: the paintings are rated on an eight-point scale assessing form, detail etc. A score of 3 gives an Easel Age of 48 months; a score of 4 gives an Easel Age of 102 months.
Appendix 2.2

Existing graphicacy tests

Graphicacy test by the Associated Examining Board
The aim of the course based on the syllabus was to help develop basic knowledge, understanding and skills in graphic forms of communication appropriate to the needs of school leavers entering employment and/or further education. The test’s objectives and content are shown in the Figure 1.

<table>
<thead>
<tr>
<th>The Associated Examining Board, 1984</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEST IN BASIC GRAPHICACY</strong></td>
</tr>
<tr>
<td><strong>ASSESSMENT OBJECTIVES</strong></td>
</tr>
<tr>
<td>a) signs and symbols commonly used to instruct, advise or warn;</td>
</tr>
<tr>
<td>b) information and numerical quantities represented in graphical form;</td>
</tr>
<tr>
<td>c) diagrammatic forms commonly used to represent planned sequences;</td>
</tr>
<tr>
<td>d) methods of representing three-dimensional objects in two dimensions.</td>
</tr>
</tbody>
</table>

**TEST CONTENT**

1. Signs and symbols (20 marks)
   a) Symbols used on domestic materials, appliances and equipment. Including textile care labelling symbols. Control symbols on kitchen equipment and symbols commonly used on domestic electronic equipment
   b) Public information signs and signs affecting pedestrians and cyclists. Including warning, information and direction signs and street markings. Refer to Highway Code.
   c) Prohibition, warning, mandatory, hazard and risk warning signs. Including fire, toxic, corrosive, radiation, electric shock and protective clothing warnings.
   d) Pictorial markings on goods or packaging. Including handling instructions for fragile, vulnerable or dangerous goods.

2 Charts and graphs (25 marks)
   a) Understanding and construction will be required, including elementary calculations, throughout this section.
   b) Bar charts, proportional bar and pie diagrams, pictograms. Examples taken from any source.
   c) Graphs. Significance of the choice of scales. Reading information from graphs but not mathematical equations.
   d) Patterns of contours, isobars and isotherms. Cross-sections will be included. Basic interpretation only of meteorological charts.

3. Flow charts and circuits (25 marks)
   a) Block Diagrams and flow charts to represent familiar operations. The standard symbols for Terminal, Process, Decision and Preparation. Operations may include school routines, home or leisure activities, transport and travel, data processing and other similar examples.
   b) Circuit diagrams - Including illustrations from the flow of liquids, gases, electricity and traffic. Associated technical knowledge will not be required.
   c) Operational sequences. Including assembly instructions given graphically.
### 4. Three-dimensional representation (30 marks)

| a) Maps and plans - Practical use of maps, street and building plans and their associated symbols. Ordnance Survey maps at scale 1:50 000 Second Series.  
| b) Orthographic representation and pictorial sketches - Transposition between orthographic and pictorial: use of grid paper. Simple perspective only. |

Figure 1 Objectives and content of the test in basic graphicacy by the Associated Examining Board
Diagnostic tests

The shape sorter task
Test description: the test requires the children to sort out chunky pieces by colour or shape.

Implementation: Children work individually, and their performance is timed.

Requirements: Recognise spatial characteristics, utilise and apply the skills listed below and to understand the spatial concepts associated with these skills. The latter included understanding spatial location, distribution and relationships, and the ability to make spatial inferences. (Wilmot, 2002:329)
Spatial skills required:
• Identifying and discriminating between different shapes
• Matching the 3D shapes to the 2D shapes on the sorter
• Selecting and judging shapes
• Orientating the sorter
• Hand and eye coordination and fine motor skills.

Results: All children completed the task. The first child to complete the task (in 20.8 seconds) was observed to be able to recognise, organise and sort the shapes (blocks) before beginning to join them. According to the author this suggested pre-thinking, planning and strategising. The last child to complete it (in 44.2 seconds) did not have a strategy for applying the skill to perform the task. He seemed clumsy and possibly lacking in fine motor skills.

Puzzle activity I
Test description: The puzzle box showing the complete picture was available as a guide (Wilmot, 2002:330).

Implementation: Working in pairs the children were asked to assemble as many of the puzzle pieces as possible within the 10 minutes

Requirements: (Spatial skills)
• Recognise and match
• Discriminate and combine colour, shape & patterns
• Identify relationships
• Classify pieces according to the previous criteria
• Orientate the pieces according to the picture shown on the puzzle box
• Attend to and transcribe scale from the picture on the box to the pieces,
• Hand–eye coordination and fine motor skills.

Results: The findings reveal that all the children were able to assemble part of the puzzle; that is, they recognised all the skills and procedures for puzzle building and were able to perform the task pieces. The score varied (19-59 pieces) which suggests that despite their knowing what to do, the levels of efficiency, consistency and success with which they were able to apply what they knew, varied considerably.

Conclusions: The findings of this study support Griffiths’ claim (1987) that knowledge should be viewed in a Rylian sense as being composed of skills embedded in conceptual understanding. The pair with the highest score appeared to have developed and implemented a strategy with a cooperative approach to learning:
• working as a team
• recognising the relationship between the pieces and the picture on the box
• using the latter to guide their efforts
- recognising and matching colours
- recognising and matching patterns
- recognising and matching shape
- concentrating on the task at hand
- have good hand-eye coordination and
- fine motor skills
- recognised the skills necessary for the task
- understood how best to apply them
- understood the conceptual basis of jigsaw puzzle building
- the concepts of spatial location
- distribution and relationships understanding

For the group with the lowest score, it appeared that the children were working independently with no encouragement or support from one another. They were unorganised and could not implement the skills they knew; they performed the task with less efficiency and success. From this one may infer that these children did not understand the conceptual basis of the skills.

**Puzzle activity II**

*Test description:* Children worked in pairs to put together cut out pieces of various shapes and sizes (all with straight edges) of a coloured poster with an abstract and symbolic picture.

*Implementation:* It required that the children assemble pieces without relying on cues provided by shape (which in a ‘normal’ puzzle provides cues for the border) and without the guidance of a picture. Further, the abstract, unfamiliar nature of the puzzle made it more challenging in that the children had no recognisable pictures to aid them. They had to recognise and use colour and pattern as cues. (Wilmot, 2002:331)

**Tangram**

*Test description:* The purpose of this activity was to investigate the children’s ability to synthesise individual elements into a larger configuration. The children were asked to use the elements (cut-out shapes of various sizes) to construct various configurations shown on a sheet of paper and then, using the same elements, to assemble a more complex configuration shown on a second sheet of paper.

*Implementation:* Working in pairs.

*Requirements:* The task also required that the children break the various configurations into their constituent parts. These required:
- Recognising and utilising spatial skills relating to size and shape
- An understanding of spatial concepts, including location, distribution and relationships
- An ability to make spatial judgements.

(Wilmot, 2002:331)

*Results:* The fastest team appeared to be more organised; they seemed to know how to tackle the task and had a strategy. They utilised all the skills necessary for this activity and they understood how to apply the skills within a broader conceptual framework. They identified, discriminated and matched colours and patterns. The also recognised and understood the significance of the symbolic picture in determining how they searched for matching pieces. The pair which recorded the slowest time did not discriminate between the different shaped pieces and thus could not understand when the pieces wouldn’t fit in.
The next set of activities/tests sought to investigate children’s spatial perceptual skills and understanding and their ability to communicate concepts using symbols. The following tasks required:

- recognition, utilisation and application of the same skills required by the previous tasks
- conceptualisation of objects/scenes which they could or could not directly observe.
- construction of a mental image of these objects/ scenes which included conceptualising spatial arrangements and relationships.

(Wilmot, 2002:333)

The Drawing a rectangular box and beaker task

*Test description:* Two tasks were designed to test the children’s’ ability to draw 2 objects placed in front of them; a rectangular box and a beaker.

*Implementation:* Children were asked to draw a side view as it was in front of them, and a second view which was not directly in front of them.

*Requirements:* Children had to illustrate:

- if and how they could draw a side view of two observable objects
- if they could form a mental picture of the objects from a view not directly observable from where they were sitting
- if they can draw the above
- their understanding of the concept of perspective
- their ability to show the reversibility of the objects in their drawings.
- their ability to orientate the objects while attending to other spatial aspects such as shape, depth and size.

(Wilmot, 2002:333)

*Results:* The results listed in Table 1 were achieved in a range of accuracy by the students. One child did not attempt the drawing. The results indicate that ‘typically’ the children understood the concept of perspective including reversibility and were able to communicate this through a drawing. ‘Atypically’ four children did not understand the concept, three of whose drawings revealed their inability to communicate it. The results reflect the Piagetian framework well, with only a small number of students unable to communicate such understanding in drawings.

<table>
<thead>
<tr>
<th>Test illustrated</th>
<th>Successfully completed by x/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape</td>
<td>15</td>
</tr>
<tr>
<td>Depth</td>
<td>13</td>
</tr>
<tr>
<td>Reversibility</td>
<td>12</td>
</tr>
<tr>
<td>Size</td>
<td>8</td>
</tr>
<tr>
<td>Relationship between objects</td>
<td>6</td>
</tr>
</tbody>
</table>

*Table 1 The drawing a rectangular box and beaker task results*
Drawing a bird's eye view

*Test description:* Draw a burner and a cup from a plan view.

*Implementation:* Children could not see the items from above but they were required to mentally form the picture in their minds and transfer that in a drawing.

*Requirements:* The test was looking to identify children’s capacity to understand a perspective other than their own.

*Results:* ‘Atypically’, three children drew both objects from an aerial view, utilising a combination of all or nearly all the skills at a consistently high level of competency. They completed both drawings with relative ease, making infrequent and minor errors. At the other end of the scale, ‘atypically’ four children experienced significant difficulty or were unable to communicate their understanding of an aerial view in graphic form (Wilmot 2002:304).

Drawing the school hall

*Test description:* Draw the school hall.

*Implementation:* The children were asked to draw the interior of the school hall which was considered a familiar but unobservable scene.

*Requirements:* This drawing relied on memory. They thus had to imagine and form a cognitive map of what it looked like without actually observing it.

*Results:* The sophistication and accuracy of the children’s drawings varied. Whilst most drawings communicated the spatial arrangement of the hall, many did so by utilising both an aerial and a side perspective (orientate the objects in relation to themselves). Most of these children concentrated on showing the shape and layout of the hall at the expense of depth, scale and object orientation in relation to themselves (Wilmot, 2002:334). This follows Lowenfeld theory of the ‘Gang/social stage’ children goes through during this age.

Drawing a route map

*Test description:* Draw a route map.

*Implementation:* This task sought to identify and describe the children’s level of skill competency when communicating information about the local environment in plan form. The maps were analysed using two methods which Matthews (1992) used when analysing maps drawn by British children of the same age.

*Requirements:* It required that the children construct a mental image of the spatial arrangement of the local environment from an aerial perspective, and then communicate this in 2D map form.

The task sought to identify:

- construction of a mental image of the spatial arrangement of the local environment
- aerial perspective
- and communicate the above in 2D map form
- method and level of representation,
- perspective and symbols.
- spatial comprehensions,
- accuracy
- spatial cohesiveness

(Wilmot, 2002:335)
Results: ‘Typically’, most children were able to draw a map in plan form, although the level of sophistication at which they did so ranged from simple pictorial-plan maps to more sophisticated plan-verbal maps. Their spatial comprehension and ability to show spatial information in a coherent and connected manner also varied considerably. ‘Atypically’, three children drew the route map in plan verbal form, utilising a combination of cartographic skills in an integrated and systematic way and at a more sophisticated level than the previous group. ‘Atypically’, two children drew pictorial maps in which many of the features were drawn ‘lying down’ along the route. These results support Matthews’ 1984 (as reported in Matthews, 1992:105) findings, that very few children by the age of 10 years draw in other than plan form, but that not every 11-year-old has developed the ability to transform environmental images topologically. From this it may be inferred that these two children had not developed the skill of rotation and were thus unable to draw the environment from an aerial perspective.

The results of the tests were based on a scale of 3 levels of competence ranging from ‘unable to utilise the skill/utilises the skill with serious difficulty’, ‘utilises the skill adequately’ and ‘utilises the skill in a sophisticated manner’.

Overall Outcome
Wilmot 2002 tests: Within a specific age group Figure 2 show that children of the same age, while tending to utilise the same skills, do so in different combinations and at different levels of sophistication.
In an unpublished paper (received through private conversation) Van Harmelen (2002) describes a series of six activities developed as a means to identify graphic skills targeted at specific spatial abilities, listed in Table 2:

<table>
<thead>
<tr>
<th>Test description</th>
<th>Spatial skills targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involved the use of the ‘shape-ball’</td>
<td>3-D to 2-D transference</td>
</tr>
<tr>
<td></td>
<td>manipulation</td>
</tr>
<tr>
<td></td>
<td>identification</td>
</tr>
<tr>
<td>jigsaw puzzles</td>
<td>colour</td>
</tr>
<tr>
<td>simple pictures cut up into a variety of shapes</td>
<td>pattern</td>
</tr>
<tr>
<td>(as used in tessellation activities)</td>
<td>shapes</td>
</tr>
<tr>
<td>drawing objects as though they were seated on opposite side of them</td>
<td>Perspective</td>
</tr>
<tr>
<td>represent objects using a ‘birds-eye’ view of fairly simple objects’</td>
<td>depth perception</td>
</tr>
<tr>
<td>Reproduce simple still life drawings (of a cube or a ball)</td>
<td>Perception of:</td>
</tr>
<tr>
<td>the cognitive mapping competencies (Harmelen, Primary Teachers)</td>
<td>elevations</td>
</tr>
<tr>
<td></td>
<td>aerial views</td>
</tr>
<tr>
<td></td>
<td>3-D to 2-D transference</td>
</tr>
<tr>
<td></td>
<td>manipulation</td>
</tr>
<tr>
<td></td>
<td>identification</td>
</tr>
</tbody>
</table>

Table 2 Van Harmelen, 2002, spatial skills tests.
Map-work related tests

Map-aerial photograph by Riding & Boardman (1983)

*Context:* Two aspects of learning style in 48 boys and 48 girls aged 14 were determined and compared. Gender differences were taken under consideration throughout the study.

*Approach:* Three-part map reading test.

*Implementation:*  
- Map-aerial photograph correlation divided into 2 parts. Both tasks required to name a number of positions identified on a photograph overlay, by using the relevant map (task 1) or a relevant second photograph (task 2).
- Symbol translation required the identification of 10 symbols form within a given grid square on the map by referring to the key provided.
- View identification was tested by joining with a one direction arrow line (indicating the direction of view) the 2 points on the map. For each position, there were 3 sketches as possible answers, one from ground level and two above ground level. The students were required to visualise what they would see if standing in point 'a' facing point 'b' and choose the relevant sketch provided.

*Methodology:* The children first had to complete 2 tests to determine their style as field-dependence-independence and Introvert-extravert.

1. Field-dependence-independence was assessed by means of the test of Embedded figures (Cuthbert, 1971) which consists of 24 complex geometrical patterns in which a simpler shape is 'embedded' or hidden and has to be identified.  
   ‘Clearly disembedding a geometrical shape from within a more complex pattern is similar to what must happen in the reading of a map where roads, contour lines, boundaries, railways, rivers and canals which together form a complex pattern must be disembedded from one another’ (Riding & Boardman, 1983:71).
2. Introversion-extraversion which relates to the verbal imagery learning style was tested through the Junior Eysenck Personality Inventory tests (Eysenck, 1965). This consists of 24 questions designed to assess introversion-extraversion and 24 for stability-neuroticism. It is considered that introverts tend to be imagers and extraverts verbalisers. It is believed that there is a verbal-imagery dimension of learning style which exerts quite a considerable influence on performance on tasks typical of those performed in the school.

*Results:* Those who were able readily to disembend a figure he termed ‘field-independent’ and those who found difficulty in this were described as ‘field-dependent’.

Small scale maps by the Schools’ Council (1974)

*Context:* The Schools’ Council ran a test in 1974 based on the careful selection of data for small scale maps. The skills of numeracy and graphicacy were interwoven in the context of a real-life problem. The skills of graphicacy and literacy can be reinforced by the juxtaposition of the verbal and visual impression of landscape.

*Approach:* Three overhead projector transparencies of the coastline of England and Wales were provided. They showed:
1. By means of green patches, the positions, shapes and sizes of the ten National Parks;
2. By red dots, the locations of all towns with over 50,000 inhabitants;
3. By black lines, all motorway routes.
In this way the three characteristics of maps-points, lines and areas- could be presented separately or superimposed, but without the distraction of unnecessary lettering.

By using the supplementary class resource-set of the National Parks pamphlet, each page can be used together or individually, each containing a small diagrammatic map of one of the National Parks and the positions of three or four settlements within it. These were used
together with a colour photograph and a short descriptive paragraph. In each case the map permitted the location of an individual park on the national base map and facilitates its identification on an atlas map.

**Implementation:** Class sets of these maps, together with copies of the relevant statistical data, were used by the pupils as a basis for time-distance and cost-distance exercises on the accessibility of the National Parks before and after the construction of the motorways.

### Following a plan of a route by Walker (1980)

(1) **Context:** Walker (1980) developed a 4 parts test using a simple plan, for children aged 5-9 years old.

(1) **Requirements:** Show skills in identifying:
- relative length;
- orientation;
- symbolisation and;
- following a route leading to a ‘treasure’ outdoors, in which they were asked to use a large-scale plan.

(2) **Implementation:** Blades & Spencer (1986) experimented in a similar way with younger children (aged 4-6 years old) by testing their abilities while using a scale model of a room. Children were asked to use the model to locate ‘treasure’ hidden in the actual room and to indicate their own position in the room of the model.

(2) **Results:** Most of the children were able to complete both tasks successfully.

(3) **Implementation:** In subsequent experiments in a nursery playground, children were asked to follow simple routes marked on a 1:50 scale plan of the playground and to find their way through a simple maze using a 1:100 scale plan showing its layout.

(3) **Results:** Many children were able to complete both tasks successfully, indicating that they could use a plan to follow the correct route through a small environment which they could see around them.

### Free-recall sketching by Matthews (1985)

(1) **Implementation:** Matthews (1985) used four different techniques with children aged 6-7 years old.

(1) **Approach:**
- free-recall sketching;
- identifying features on an aerial photograph;
- identifying features on a large-scale map and;
- verbal reporting.

The aerial photograph was centred on the school and a sheet of tracing paper placed over it enabled the features identified by the children to be recorded. The same procedure was used with the large-scale map but all written information was erased from it so as to avoid prompting.

(1) **Results:** The children experienced difficulty when attempting to give a verbal description of an area, but were able to give better representations with the aid of the aerial photograph or large-scale map. Free-recall sketching, on the other hand, was found to be the best method of enabling children to recall their journey to school.

(2) **Implementation:** Boardman conducted a similar study (as referred in Section 3.5) with 14-years-old pupils

(2) **Approach:** Several tasks involving maps, photograph and sketches were attempted.
(2) Results: The results suggest that map-reading performance depends on the learning style and sex of the pupil and on the type of task (Boardman 1990:62).

Indications of developmental nature on mapping abilities by Hart (1979)

Implementation: Children aged 6-11.

Methodology: Children were asked to place toy items on a piece of paper in a way to represent the area around their homes. He then traced round the models and wrote alongside them the names of places that the child gave him. After removing the models he congratulated the child on having made a map; this was the first time that he used the word ‘map’.

Working with contour lines by Boardman (1983)

Implementation: 579 fifth year pupils (aged 15-16 years).

Methodology: The students were asked to shade all the land below the height of the third of seven contours shown on the map.

Results: Only 49% of the pupils completed the task successfully. The mistakes made by the remaining pupils arose mostly from a failure to appreciate the continuous fall in the height of the land between successive contours.

Working with contour lines by Boardman (1989)

Implementation: 11-12 and 13-14 years old students.

Methodology: Subsequent questions used in the studies of the first-, third- and fifth-year pupils to test their understanding of the representation of relief on a map, Boardman asked them to:
- look at each of the several short lines in turn
- decide which end was higher and
- draw a circle round that end
- identify which of the lines lay on the steepest slope and
- estimate the height of the land at given points on the map.

Results: Students found it difficult in visualising the three-dimensional landscape from the two-dimensional map using the contour lines. Some of the erroneous perceptions were revealed when pupils where asked to shade all land above a certain height on a sketch map showing only the contours of four heights. Only 36% of the first year pupils (11-12 years old) and 75% of the third year pupils (13-14 years old) correctly shaded a small map containing contours drawn at four heights.

Intelligence matters by Ghuman & Davis (1981) (as referred in Section 3.5)

Context: Investigate whether mapping abilities might be related to age, general intelligence and maturity of thought

Implementation: 102 pupils aged 12-15 years.

Results: The results of this study suggested that older and more mature thinkers, using the criteria adopted by Peel (Peel, 1971), were better at 2-dimensional orientation and appreciation of complex shapes on maps. There was no evidence from this study that age or maturity of thought assisted either with basic map-reading skills or in comparing 3-dimensional images with the map. Performance in all tests was found to depend more on general intelligence than on either chronological age or maturity of thought.
Difficulties and misinterpretations in map reading by Boardman (1983)

Context: Some of the problems encountered by pupils in correlating maps and photographs were investigated as part of a study of graphicacy in school-leavers.

Methodology: Children where tested by asking them to correlate items from a picture and a map.

Results: The pupils generally overestimated the area of the map shown on the photograph and did not identify the correct direction the photograph was taken from. Oblique aerial photographs differ from vertical aerial photographs. The differences in scale, together with the distorting effects of perspective, often make it difficult to correlate the photograph with the map.

Visuospatial abilities by Harris (1981)

Context: Harris carried out a test for spatial visualisation, which he defined as the ability to manipulate or rotate two- and three-dimensional pictorially presented visual stimuli such as recognising and reading the signs and symbols on a map when it is not held the right way up. Spatial orientation was also an element tested, and was defined as spatial pattern of visual stimuli which might be presented such as reading a road map held with north at the top in a moving vehicle which is travelling south.

Requirements:
Skills:
• Mental rotation;
• Perceptual disembodying;
• Way-finding ability;
• Visual spatial ability (perception and manipulation of spatial relationships such as identifying which of a series of shapes is a rotation of a sample shape).
Appendix 3

AQA References


Appendix 4.1 Articulating the meaning of the categories from the new taxonomy

### Artistic/ pictorial/ graphic arts

I. **Art**: Art is the process or product of deliberately and creatively arranging elements in a way that appeals to the senses or emotions ([http://en.wikipedia.org/wiki/Art](http://en.wikipedia.org/wiki/Art))

II. **Life drawing**: Life drawing refers to the process of drawing living beings and figures from observation of a live model ([http://en.wikipedia.org/wiki/Figure_drawing](http://en.wikipedia.org/wiki/Figure_drawing))

III. **Landscape**: Landscape drawing comprises the visible features of an area of land, including physical elements such as landforms, living elements of flora and fauna, abstract elements such as lighting and weather conditions, and human elements, for instance human activity or the built environment ([http://www.babylon.com/definition/landscape/English](http://www.babylon.com/definition/landscape/English))

IV. **Portraits**: A portrait is a painting, photograph, sculpture or other artistic representation of a person, in which the face and its expression is predominant. The intent is to display the likeness, personality, and even the mood of the person ([http://en.wikipedia.org/wiki/Portrait](http://en.wikipedia.org/wiki/Portrait))

V. **Still life**: A still life (plural still lifes) is a work of art depicting mostly inanimate subject matter, typically commonplace objects which may be either natural (food, flowers, plants, rocks, or shells) or man-made (drinking glasses, books, vases, jewellery, coins, pipes, and so on) in an artificial setting ([http://www.answers.com/topic/still-life](http://www.answers.com/topic/still-life))

### Drawing/ pictorial

IV. **Draft**: A draft is a copy of a material made for examination and correction before the final production ([http://www.ask.com/web?q=dictionary%3A+draft&content=ahdict%7C43491&o=0&l=dir](http://www.ask.com/web?q=dictionary%3A+draft&content=ahdict%7C43491&o=0&l=dir))

V. **Sketching**: A hasty or non-detailed drawing or painting which is a brief general account or presentation often made as a preliminary study ([http://www.ask.com/web?q=dictionary%3A+sketching&content=ahdict%7C138644&o=0&l=dir](http://www.ask.com/web?q=dictionary%3A+sketching&content=ahdict%7C138644&o=0&l=dir))

VI. **Drawing**: A picture or plan made by means of lines on a surface representing objects or forms ([http://www.thefreedictionary.com/drawing](http://www.thefreedictionary.com/drawing))
### Diagrams/ pictorial

I. **Annotated:** A figure or drawing made to illustrate a statement or facilitate a demonstration (a diagram) with a series explanatory notes (http://www.biology-online.org/dictionary/Annotated_Diagram)

II. **Engineering/ technical:** A graphical language used by engineers and other technical personnel associated with the engineering profession. The purpose of engineering drawing is to convey graphically the ideas and information necessary for the construction or analysis of machines, structures, or systems. (http://www.answers.com/topic/engineering-drawing)

III. **Architectural:** Rendering or drawing of an architectural design as plan and/or elevation views of a building or structure (http://www.businessdictionary.com/definition/architectural-drawing.html)

IV. **Projections** (orthographic, isometric, oblique): **Orthographic projection** is a means of representing a three-dimensional (3D) object in two dimensions (2D) (http://en.wikipedia.org/wiki/Orthographic_projection)

V. **Perspective:** Perspective in the graphic arts, such as drawing, is an approximate representation, on a flat surface (such as paper), of an image as it is perceived by the eye (http://en.wikipedia.org/wiki/Perspective_(graphical)

VI. **Exploded:** An exploded view is a representative picture or diagram that shows the components of an object slightly separated by distance, or suspended in surrounding space in the case of a three-dimensional exploded diagram (http://en.wikipedia.org/wiki/Exploded_view)

### CAD/ spatial

I. **Computer aided images:** Use of computer programs and systems to design detailed two- or three-dimensional models/images (http://www.thefreedictionary.com/computer-aided+design)

II. **3D virtual images:** Computer-aided design (CAD) is the use of computer technology to aid in the design and particularly the drafting (technical drawing and engineering drawing) of a part or product, including entire buildings. It is both a visual (or drawing) and symbol-based method of communication whose conventions are particular to a specific technical field. (http://en.wikipedia.org/wiki/Computer-aided_design)

### Sequential / lineal

I. **Cartoons:** An often humorous or satirical drawing to evoke emotions, usually with a caption. A cartoon is typically a simple-lined drawing and tells a story or continues a story; it can consist of one or more pictures or frames (www.worldimages.com/art_glossary.php)

II. **Story boards:** Originally, a series of drawings that lay out the sequence of scenes in a film, especially an animated one, but now any sequence of drawings (en.wiktionary.org/wiki/storyboard)

**Spider diagrams/ brainstorming:** Brainstorming is a group creativity technique designed to generate a large number of ideas for the solution to a problem (en.wikipedia.org/wiki/Brainstorming)

III. **Flow diagram:** Graphic means of presenting an overview of how processes work, usually consisting of graphic boxes and other shapes, and lines and arrows (www.techcommunicators.com/dkmanual/glossary.html)
Symbolic/quantitative

I. **Charts and graphs**: A chart or graph is a type of information graphic, that represents tabular numeric data and/or functions ([en.wikipedia.org/wiki/Chart](en.wikipedia.org/wiki/Chart))

II. **Symbols**: A symbol is something such as an object, picture, written word, a sound, a piece of music, or particular mark that represents (or stands for) something else by association, resemblance, or convention, especially a material object used to represent something invisible ([en.wikipedia.org/wiki/Symbols](en.wikipedia.org/wiki/Symbols))

Symbolic/spatial

I. **Maps**: A map is a visual representation of an area—a symbolic depiction highlighting relationships between elements of that space such as objects ([en.wikipedia.org/wiki/Map](en.wikipedia.org/wiki/Map))

II. **Photographs**: A photograph (often shortened to photo) is an image created by light falling on a light-sensitive surface, usually photographic film ([en.wikipedia.org/wiki/Photographs](en.wikipedia.org/wiki/Photographs))

III. **Advertisements**: advertising - communication whose purpose is to inform potential customers about products and services ([en.wiktionary.org/wiki/advertising](en.wiktionary.org/wiki/advertising))
Appendix 4.2 Aim of the Survey letter

**PhD research**

**Aim of the survey**

By Xenia Danos

Department of Design and Technology, Loughborough University, UK

In our schools’ curricula, we find literacy, numeracy and articulacy being the main areas of focus across the subject areas. In all subjects, lessons are taught mainly with the use of verbal and visual communication. Despite this, the teaching of understanding and working with different types of images is rarely given adequate time in curricula. Students and teachers are expected to grow naturally the ability to understand, read and use images and symbols.

Research conducted in the past has highlighted the importance of visual communication in a variety of subjects, including the sciences, mathematics, geography and art and design. The term ‘graphicacy’, has been used by geographers in the past to describe the skills required to read and understand maps. Mathematicians have used it for the ability to deal with mathematical graphs and charts.

An extensive literature review has shown that graphicacy fits into a more general context. Graphicacy is the basic skill of communicating through visual images. Examples are graphic arts, drawings, diagrams, computer aided images, cartoons, story boards, graphs, symbols, maps, photographs and advertisements.

The aim of this survey is:

1. to investigate how visual communication (graphicacy) is used across the curriculum within an American secondary school
2. how teachers use it in the classroom
3. how teachers expect their students to deal with this visual information.

The long term goal of this study is to investigate and identify the effects graphicacy has on students’ learning.

I will be visiting the school (relevant dates) with the hope of conducting 30 min long individual meetings with teachers from various disciplines.

For any further information or to set a time for a meeting, please contact me via e-mail at xeniadanos@hotmail.com.

Your contribution to this research will be highly appreciated. I am expecting to report my findings in a research report which is to be published in a scholarly journal later in the year, and I will be happy to share it with everyone at your school, which I could make available to anyone interested in reading it.
Appendix 4.3 Implementation & methodology of pilot study 1

Step 1: Informed Mrs Stephanou of the research and the aim of the study to be undertaken in the school. This was achieved through a written summary of the aim and objectives of the study (Figure 6.4), and an active conversation and discussion of the graphicacy taxonomy. Mrs Stephanou agreed to talk to the school principal and the teachers and prepare the ground for the study. On 10/12/08 the first meeting was conducted at Mrs Stephanou house. The meeting was kept informal and on friendly levels, and lasted for 2 hours. Over this time, a thorough analysis of the textbooks used in school was conducted. Mrs Stephanou answered all questions mentioned above and gave clear examples of how each image was used in class and at home as homework. Clear indications of her expectations towards students’ knowledge and understanding of how to deal with different images were discussed. This was the only discussion conducted in Cyprus which was agreed to be audio recorded. (Annex 1)

Step 2: Initial discussions with Mrs Kyriakidou on the research work, the taxonomy of graphicacy and the aim and objectives of this study were instigated. The document informing the aim and objectives of the study (Figure 6.4), the taxonomy of graphicacy used as my research tool (Figure 6.3) and the consent shown in Figure 6.5 were translated in Greek with the help of Mrs Kyriakidou.

Figure 6.3.1 The Consent form

<table>
<thead>
<tr>
<th>Consent form</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name:</strong></td>
</tr>
<tr>
<td><strong>Subject:</strong></td>
</tr>
<tr>
<td><strong>Affiliation:</strong></td>
</tr>
</tbody>
</table>

The purpose of the research has been fully explained to me and I give permission for my answers to the interview questions to be used **anonymously/with acknowledgement (please delete as you prefer)** in the project report and any subsequent related publications.

I also **do/do not (please delete as preferred)** give permission for the interview to be recorded on the understanding that the recording will be destroyed within one year following the publication of the report.

I also understand that I can withdraw from the interview and/or research project at any point and without being required to give any explanation.

Signature:       Date:

© Loughborough University, Department of Design and Technology, 2008/9

Step 3: The principal of the school gave a verbal approval for the study to be undertaken in the school. He passed terms and conditions via Mrs Stephanou. These included; no student to be interviewed or photographed during the visit, and use the school anonymously. The first day of the study, the principal came to introduce himself and share best wishes towards the study.
**Step 4:** The school has 3 main areas used as staff rooms during free time of the staff. A large discussion table was allocated for the duration of the study. The first hour before school classes commenced, time was spent meeting and introducing the teachers. During this time, a simple but clear explanation of the aim of the study was given to the teachers (in Greek). This was as follows:

> 'The aim of the study is to identify in which subject areas the types of images forming the taxonomy for graphicacy are used. The textbooks used in class will be required during the meeting. During the meeting a discussion will unfold between the researcher and the participant in regards to the use, function and students' perception for each type of image. The main purpose of this study is to see if images are widely used across the curriculum.'

Appointments were made to meet willing teachers during their free time.

### Conducting the pilot study in Cyprus

**Step 5:** The first participant requested to start with a group session. Three teachers came together for this first session. The aim of the study was explained, this time while using the research tool developed for this study; the taxonomy for graphicacy with the images and explanation of each type of image. Their rights were described for during and after the interview, and they were asked to sign the acknowledgment form. All three teachers were very hesitant in signing the form.

**Step 6:** A thorough explanation of the reasons behind the requirements of complying with the regulations on signing the form were explained, backed up by Mrs Stephanou. None of the teachers in the school during the 3 days study in Cyprus agreed to audio record the discussions. Once the forms were signed, examples of how the meetings would be conducted were demonstrated by the researcher. This was done first by talking through the different types of images shown in the research tool, commenting on the functions of the image in different subject areas. In addition, examples of types of images found in a textbook where identified. Discussions on their purpose, function, suitability and students’ perception towards it were initiated while encouraging the teacher to get involved in the conversation.

**Step 7:** The first teacher was encouraged to start discussing images from the textbook. After the first 10 minutes the tension calmed and all three teachers became active into the conversation. New appointments were made for the 2nd of 3rd teacher for a later time. The meeting continued with one of the teachers.

**Step 8:** Textbooks analysis and discussion took place for approximately 30 minutes. Comments and observations were noted down by the researcher during the interview.

**Step 9:** Textbooks were then photographed by the researcher as evidence. During this process, photographs of different types of images within each category from the taxonomy where taken. Same type of images found multiple times were not photographed throughout. The aim of this study was to collect qualitative data by identifying the different types of images used in every subject. The number of times each type of image is used was not relevant in this initial stage of the study. In total, 1026 photographs were taken (Annex 6.1). Often a photograph included evidence of a number of different types of images in use.

**Step 10:** In some cases, teachers felt necessary to take a tour of their classroom as a lot of visual aids used in the lesson were mounted on the walls. In these instances, photographs of those images were taken and used in the analysis of data collected for this study.
Appendix 4.4 Implementation & methodology of case study 1

Step 1: Informed Mr Janes of the current research and the aim and objectives of the study to be undertaken in the school. This was achieved through a written summary of the aim and objectives of the study, as it was done in the Cypriot school (Figure 6.4), and further exchange of emails. Mr Janes agreed to talk to the school principal and the teachers and prepared the ground for the study. It was requested by Mr Janes to provide a flier informing and encouraging teachers to take part in this study (Figure 6.6). The flier was placed in all staff room areas of the school approximately 2 weeks before the study. The study was conducted over three days, the 6th, 9th and 10th of February 2009.

Step 2: The principal of the school gave a verbal approval to Mr Janes for the study to be undertaken in the school. He passed terms and conditions via Mr Janes. These included; no student to be interviewed or photographed during my visit, use the school and any work of the students' photographed anonymously.

Step 3: Interested teachers requested a meeting time and date through email. Teachers were informed of what they were expected to bring with them and how the interview would run. The template used for these emails is given below in Figure 6.7

---

Dear X,

Thank you very much for your email! How about we say (Day, date) of February at (time)? It would be very useful if you could bring the text books and other resources you use during your lessons like posters or handouts etc. I would also be interested in seeing what the students are expected to produce at different levels, so if there are exercise books or old student's project work I would be very interested in taking a look at them.

Through the meetings I need to establish the importance of visual communication in different subjects, through:

1. talking about the ways lessons are conducted, and
2. through text books analysis.

The analysis of my data from this meeting will take place in June-July, so I will have to document each well so I don't lose any data (forget information). I am hoping to be able to voice record each meeting and be able to take photographs of pages from textbooks, exercise books, worksheets and any other resources brought by each teacher. So while we are discussing I can be taking pictures of examples of images from the text books used as well as any other relevant resources. i.e. posters, handouts, worksheets etc.

Thank you very much for offering to help me with my study! I am much exited to be doing work in the USA and the response I got so far is very encouraging. If you have any questions about my work or the interviews, please feel free to email me back.

I am looking forward in meeting you!

Kind regards,

Xenia Danos

---

*Figure 6.7 Template for meeting appointment*
**Step 4:** The first day of the study, the formal introduction between the researcher and Mrs Janes was completed. Up until that point all communication between the two was through the internet. A tour of the school was conducted before the first classes of the day commenced. As most teachers preferred the discussion to take place in their classrooms where they held most of the textbooks they use, those classrooms where identified and marked on a hand held school map. A classroom was allocated as a point of reference and an area to be used in-between the discussions and for taking photographs of the textbooks.
Appendix 4.5 Implementation & methodology of case study 2

Step 1: During a private meeting Mr Macfrici was informed of the current research and the aim and objectives of the study to be undertaken in the school. A number of resources used in the previous case study and pilot study were discussed. These included: aims and objective of the main research, the taxonomy, aim of this case study, consent form and a plan of how the case study would be completed.

Step 2: Mr Macfrici agreed to talk to the school principal and the teachers to prepare the ground for the study. Teachers from the following subject areas provided textbooks they use in class. These were collected by Mr Macfrici ahead to the agreed dates of the study; 4th and 5th of February, 2010.

Step 5: The structure of the discussions run in a very similar manner as they did in Cyprus. A consent form was signed to agree on the acknowledgement of the participant's rights during and after the discussion. Thereafter, the discussions were tape recorded. The aim of the study was provided as with the teachers from the previous school.

Step 6: Textbooks analysis and discussion took place for approximately 30 minutes.

Step 7: Textbooks were then photographed by the researcher as evidence. During this process, photographs of different types of images within each category from the taxonomy where taken. Same type of images found multiple times were not photographed throughout. The aim of this study was to identify the different types of images used in every subject. The number of times each type of image is used was not relevant in this initial stage of the study.
Appendix 4.6 Introductory email to the teachers of the design and technology department of a secondary school

Dear X,

My name is Xenia Danos, I am a PhD student from Loughborough University, working on establishing visual literacy as one of the main 3 modes of communication (the other being literacy and numeracy). Mr Macfrici has been kind enough to allow me to observe lessons, get involved and even take part in some teaching (if needed), in an effort to observe and note down stages children go through while learning how to create different types of images (such as maps, flow diagrams, still life drawing, symbols etc).

I have studied the schemes of work currently been taught in your department, and have created a table illustrating possible opportunities for my research. on the table (attached with this email), on the left hand side are all the different types of images I have identified through literature review, and on the top, the projects that could potentially help me analyze learning progression stages. I have written down the week I think is relevant to each one, but that might be inaccurate.

I will have to observe lessons being taught on how to create different types of images. I will be noting down the different stages I identify students have to go through before they can successfully complete each type of image. I might often ask to take in students' work and scan it before I return back the originals. This will help me identify 'smaller' progressions stages/ descriptors. In my thesis and other work, everything I reference taken from this study, will be done so anonymously.

I have to complete this work by the end of January the latest, but preferable most of the work will be completed before we break away for Christmas time.

I would like to meet with you to talk a bit more on what I am looking to get out of this and how we might work together to achieve that, if you are interested. I am a qualified teacher which means that:
- I can take on a few sessions, giving you some more free time to use as you like
- create tasks and other teaching aids to enhance certain lessons
- take tasks with me to evaluate and write feedback for future goals etc for each student.

I can come to your school on date, day, and time for further discussions. The only restriction I have for my work is time, as the deadline for this work is the end of January.

I am very looking forward to further discussions.

Kind regards,

Xenia Danos
Appendix 4.7 Star Profile lesson plan

23rd December, 2010; 13:20 - 14:20, 24th December, 2010, 9:00 - 10:00

Year 7 Lesson Plan, Food Technology

Lesson input: STAR PROFILE

Introduction
- How to draw a star profile
Why do we use it?
Task: Draw using a ruler a star profile for 4 criteria
Evaluate your product

Deliver lesson on
Q. what other criteria can you think we could have/use to evaluate a food product?
Write on board: texture, look, colours, taste, quantity/size, healthy option, price, preparation time, cooking time, easy recipe, waste, smell (5 min)
Q. How can we illustrate 8 criteria on paper?
Task: draw ideas on handout – leave one blank for correct answer (3 min)
Show correct answer on board. Explain students how to use their rulers to draw lines (5 min)
Q. How can we illustrate 6 criteria on paper? (3 min)
Task: draw ideas on handout – leave one blank for correct answer
Show correct answer on board. Explain students how to use their rulers to draw lines (5 min)
Q. How can we illustrate multiple product evaluations on one star profile?
Task: draw ideas on handout – leave one blank for correct answer (3 min)
Show correct answer on board. Explain students how to use their rulers to draw lines (5 min)

Overall time: 30 min

Notes:
Notes to be taken during the observation
Students must complete the information on the top of the handouts
Student work to be photographed

Equipment:
2 star profile handouts x30
30/60 – 45/45 rulers or a Protractor x30
4 colours x30
Photographic camera

A number of handouts and teaching aids were produced for the lesson. These are provided in a digital form as Annex 6.5.
Appendix 4.8 Year 7 profile drawing, curriculum day, lesson plan

21 students Year 7 – Curriculum day, 7th of December 2010
Xenia Danos (Loughborough University)

4 students: short attention span, difficulties
2 students: gifted and talented

Sequence of lesson/ tasks:
1. Explain the lesson
   Focus on
   i. sketching not drawing (explain the difference)
   ii. portraits: front and profile
   iii. self portraits
   iv. caricatures
   v. cartoons/ super heroes
   vi. sequential drawing/ story board

2. Sequence of lesson
   Period 1
   i. 10’ Explain rules, acceptable behaviour etc
   ii. 10’ Explain the lesson
   iii. 10’ Task 1: draw a portrait (explain to them what to do but not how to do it, part of their progression record)
   iv. 10’ Explain proportions of the face
   v. 15/20’ Task 2: Using tools, create a template mapping out the location of facial features (ruler, pencil, protractor, eraser, A4 paper-name, date) step-by-step guidance. (less able students can have adult one-to-one support. Next stage would be a half prepared template for them to complete with adult support. Next stage would be a complete guide prepared for them. They will have to label the correct lines)

   Period 2
   vi. 10’ Difference between sketching and drawing. Explain & class discussion of examples. This lesson will be dealing with sketching techniques.
   vii. 25’ Task 3: Step by step guidance to create a standard male portrait
   viii. 10’ Discussion of what they have learned, self and peer assessment.
   ix. 25’ Task 4: Step by step guidance to create a standard male profile

   Period 3
   x. 5’ Discussion of what they have learned, self and peer assessment.
   xi. 25’ Task 5: Step by step guidance to create a standard male portrait. Students are then to alter the facial characteristics to match the face from a picture provided to them
   xii. 25’ Task 6: Step by step guidance to create a standard male profile. Students are then to alter the facial characteristics to match the face from a picture provided to them

   Period 4
   xiii. 25’ Task 7: Create a self portrait. Use the mirrors.
   xiv. 10’ Lessons and discussion on what makes a successful caricature
   xv. 20’ Task 8: Students to turn their self portrait into a caricature
   xvi. 15’ Task 9: How to make a cartoon & emotions: eyes, eyebrow, nose, mouth, chin/shape of face, hair

   Period 5
   xvii. 20’ Task 9: Make your own cartoons (step by step guidance first 10 min)
   xviii. 15’ Task 10: Turn your caricature into a cartoon
   xix. 15’ Task 11: Look at examples of super heroes. Turn your caricature into a superhero.
   xx. 15’ Task 12: draw a portrait (explain to them what to do but not how to do it, part of their progression record)

Extension tasks:

2 Tasks to be completed if time permits. In case the time plan has not been followed, these tasks are to me removed from the schedule.
Ex. Task during the lesson: more able students can be given a booklet with step by step instructions on how to create the portraits. That might help me keep engaged and interested as they can work using the speed that best suits them (Yates Philip perhaps? Has been described as capable but can’t process information as easy or fast as other students).

Ex. Task 1: Create a story board with a sequence of 10 boxes, illustrating a short story with your super hero.
Ex. Task 2: add colours to the story board characters

**Less able students:**
Stage 1: Less able students may have adult one-to-one support.
Stage 2: A half prepared template for the student to complete with adult support.
Stage 3: A complete guide prepared for the student. They will have to label the correct lines

**Equipment**
- 21 mirrors
- HB pencils
- Sharpeners
- Erasers
- Rulers
- Protractors
- A4 paper sheets

Guidance sheets:
- Guidance layout sheets for front portraits
- Guidance layout sheets for profile portraits
- Guidance sheets for front portraits photograph
- Guidance sheets for profile portraits photograph
- Examples of caricatures (also provided on the projector screen)
- Examples of cartoons (also provided on the projector screen)
- Story board layout sheets
- Different stages (3 stages) of guidance layout sheets for the less able students for front portrait, profile, caricatures and cartoons

On the computer:
- Images of portraits in drawing
- Images of portraits in sketching

**Adult support**
A teacher trainee will be joining this lesson. Tasks and teaching aids will be given to him in advance. This lesson plan will also be emailed to him. It has been suggested to complete all tasks the students will be required to complete that lesson to better understand and indentify difficulties students might come across and therefore provide specific and detail help where necessary.

**Risk assessment**
**Mirrors**
Students will be required to work with mirrors. Mirrors will be placed in front of each student by an adult, in the middle of the large benches (where students will be sited). Students will be given direct instructions not to handle the mirrors more than needed. They will be required to place it so they can see clearly their reflection. Before mirrors are placed on the bench, students will be given direct instructions in case a mirror is cracked or broken. Students are to calmly walk away from the broken or cracked mirror. Inform an adult immediately. Cracked mirrors are to be wrapped in old papers securely and placed in the bin. Large broken pieces will be collected by hand by an adult (teacher, teacher trainee or other adults in the room). Smaller pieces can be collected using a small brush. A vacuum machine will be needed to collect all tiny pieces at the end.
A first aid kid is available in the classroom for minor cuts. Minor cuts can be treated by the teacher in the classroom. More severe cuts can be treated by the teacher until a first aider comes to take over. In such an event the front office will be contacted.
All broken pieces of glass will be wrapped in layers of paper, taped securely and thrown away.
Protractors

Protractors have one pointy end which could pierce the top layer of skin. It would potentially be very harmful to eyes, as it is a sharp object. Students will be given strict instructions on the acceptable and correct use of the tool. No misbehaving will be accepted. If students have difficulty in using the tool correctly, it will be taken away from them and they will be penalised appropriately. If there are any accidents, the same first aid procedure will be followed as described above.

A number of handouts and teaching aids were produced for the lesson. These are provided in a digital form as an Annex.
Appendix 4.9 Correspondence relating to the Delphi group

Round 1 Invitation to participate in the Delphi study

Dear (enter name),

I am writing to invite you to join a Delphi group focused on validating continuity and progression descriptors of graphicity drawn from research.

Graphicity is a basic communication skill, based on the abilities to communicate through still visual images such as graphs, maps, diagrams, symbols and drawings.

My name is Xenia Danos, I am in my third and final year of my PhD studying at the Design School of Loughborough University, UK. My research is focused on elements of graphicity (Figure 2 in the attached document ‘a methodology and a research tool’) and the skills involved within these. The primary current focus on the research is on the abilities and educational continuity and progression stages involved with certain graphicity elements.

Having you as a member of this group would enable you to comment and influence this current research concerning graphicity in the curriculum. I hope to get the opportunity to work together for this short period of time.

(Added why the individual was chosen, what can they gain out of this and how can their existing knowledge and expertise can be used in this study)

There are two attachments with this email. The first is called ‘Methodology and a research tool’, which describes the way this Delphi group could work. Additionally, there is a description of a key research tool developed and used in this research. The second attachment, ‘Question sheet 1’ signals the first Delphi group study, focusing on the appropriateness of the method of the Delphi group study, and the taxonomy of graphicity. The answer sheet has been designed to minimise the demand on your time as the respondent.
For this Delphi group study, there are 3 areas to be looked into:
1. The taxonomy of graphicacy,
2. Cross-curricular links identified regarding image use.
3. Continuity and progression descriptors when dealing with different elements of the
taxonomy.

The study is aimed to conclude by the end of May 2011 as the thesis is planned to be
handed in by the end of June 2011.

If you would like to take part in this study, please look at how the Delphi group will
work (attachment ‘methodology and research tool’) and then answer the questions on
the question sheet (attachment ‘Question sheet round 1’). Please send your answers
by the 19th of February 2011. The second round of discussion 1 will be sent out along
with discussion 2, concerning cross-curricular links by the 26th of February 2011.

**Invitation to join the Delphi group**

Would you like to take part in this Delphi group study? Yes / No

Could you suggest anyone else who would be interested in taking part in this Delphi
group?

Thank you for your time in reading this email. I look forward to future discussions.

Xenia Danos
Introduction of discussion 1: A methodology and a research tool

By Xenia Danos, 2011

Delphi group methodology

As experts, you will be asked to give your opinion (otherwise known as ‘forecasts’) on the issue at hand, which will be clearly explained in an appropriate form, varying from questionnaires to open questions. Answers will then be collated; processed and focussed. Any common and conflicting viewpoints will be identified. The outcome will then be sent back to all the experts who are part of the Delphi group. You will be asked to comment on your own forecasts, the responses of others and on the progress of the panel as a whole. Results will be processed again by myself, the panel director, and sent out for further review (Figure 1).

All participants will maintain their anonymity to allow free expression of your opinions and encourage you to openly critique and change your judgments as appropriate. Participants will be mainly from UK, Cyprus and the USA.

Figure 1 Visual representation of the Delphi technique

The communication will be based primarily on the exchange of emails. Once new information is sent, participants will have 7 days to respond. Information will then be gathered, analysed and reported back within a week. This study is aimed to conclude by the end of May 2010 as the thesis in planned to be handed in by the end of June 2010.

A question relevant to the above methodology can be found on the top of Question sheet 1. Please look at the taxonomy (described below) and fill in the remainder of the question sheet 1.

A taxonomy of graphicy

The taxonomy (Figure 2) was initially developed as a research tool, to investigate how graphicy is used in schools and if so, to map it across the curriculum. Ultimately, it was used to structure the identification of continuity and progression descriptors of necessary skills and abilities when dealing with different elements (types of images).

The taxonomy was developed through five stages:

- Developing categories from the literature review
- Identifying learning skills and purposes of images;
- Visually representing the emerging concept of graphicy;
- Articulating the meaning of the main categories; and
- Defining the new taxonomy of graphicy.

(Danos & Norman (1), 2009)

The taxonomy has 8 categories, and each category consists of different elements. The categories have been organised so as to accommodate all types of images (elements), which are used to cultivate the same or similar learning outcomes. For example, the elements under...
the category of graphic art could be used as a tool/aid to help people with learning activities. Perhaps, to understand themselves, the world around them and how they respond or feel about it. The taxonomy is a modern, cross-curricular framework which can be used to explore graphicacy across all years of secondary education. In order to explore some of the 24 elements of the taxonomy (excluding the elements form the 'other' category), tasks were created focused on various relevant graphicacy skills.

**Validation of the taxonomy**

The taxonomy has so far been used successfully as a research tool to map graphicacy across the curriculum in 3 schools, one in; Cyprus, the USA and the UK (Danos & Norman (2), 2009). It has been used successfully as a research tool during co-research i.e., by independent researchers (Danos et al., 2010). The co-research was focused on identifying continuity and progression descriptors in Key Stage 3 (during the first 3 years of secondary education, relating to students aged 12 – 14 years old). The taxonomy has been presented in conferences such as the Design & Technology Association conference 2009 and the International Visual Literacy Association conference 2010 (Danos & Norman, 2010). The relevant papers have been accepted for publication.

**Figure 2 A taxonomy of graphicacy**

This category represents:

- To help people visually explore and understand themselves and the world around them, how they respond or feel about it. Usually the item produced is a finished product itself.

- Well finished products that closely mirror an idea/observation. This is a means to achieve/get to the next stage.

- Technical diagram to define clearly features, details and/or requirements such as relationships, processes, components.

- Illustrate the sequence of a thought, process or story. Image follows a relative sense of direction.

- Symbolic representation of data, information and/or warnings.
References


Danos X (2) and Norman E W L, ‘An Initial Comparison of Graphicacy within the Curricula of Two Schools in Cyprus and the United States, D&T - A Platform for Success: The Design and Technology Association Education and International Conference 2009, Dr Eddie Norman and Dr David Spendlove (eds), The Design and Technology Association, Loughborough University, July 2009, 115, ISBN 1 898788 85 5.

Danos X, Norman E W L, Robson J., Storer I., ‘Identifying continuity and progression in the development of graphicacy’, D&T – Ideas worth sharing: Education and International Research Conference 2010, Dr David Spendlove and Professor Kay Stables (eds), The Design and Technology Association, Keele University, July 2010

Delphi group discussion 1

Name:

Question 3: Do you think the Delphi group method described is appropriate/doable?
Yes / No

Comments:

Question 4: Figure 3 illustrates the categories of the taxonomy of graphicity. The elements within each category are included along with a written description.

- Are the categories the ones you would expect? Please indicate if you consider each category appropriate or not, by ticking the relevant box next to the title of each category.

Are the elements within each category found in the taxonomy of graphicity the ones you would expect? Please indicate your answer by placing a tick in the relevant box above the image and title of each element.

Question 5: Are there any elements which you feel have been missed out?
Yes / No

If yes, please indicate within which categories you think they are part of. You can write your comments in the boxes provided in Figure 3.

Figure 3 A review of the taxonomy of graphicity

<table>
<thead>
<tr>
<th>Graphic Art Category</th>
<th>Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART</td>
<td>To help people visually explore and understand themselves and the world around them, how they respond or feel about it. Usually the item produced is a finished product itself.</td>
</tr>
<tr>
<td>LIFE DRAWING</td>
<td></td>
</tr>
<tr>
<td>LANDSCAPE</td>
<td></td>
</tr>
<tr>
<td>PORTRAITS</td>
<td></td>
</tr>
<tr>
<td>STILL LIFE</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drawing Category</th>
<th>Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAFTS</td>
<td>Well finished products that closely mirror an idea/observation. This is a means to achieve/get to the next stage.</td>
</tr>
<tr>
<td>SKETCHING</td>
<td></td>
</tr>
<tr>
<td>DRAWING</td>
<td></td>
</tr>
</tbody>
</table>
### PICTORIAL / DIAGRAMS

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSPECTIVE</td>
<td>ARCHITECTURAL</td>
</tr>
<tr>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

**Comments:**
Technical diagram to define clearly features, details and/or requirements such as relationships, processes, components.

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPLODED</td>
<td>PROJECTIONS (ORTHOGRAPHIC, OBLIQUE, ISOMETRIC)</td>
</tr>
</tbody>
</table>

### SEQUENTIAL / LINEAL

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARTOONS</td>
<td>STORY BOARDS</td>
</tr>
<tr>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

**Comments:**
Illustrate the sequence of a thought, process or story, image follows a relative sense of direction.

### SYMBOLIC, QUANTITATIVE / ABSTRACT

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHARTS &amp; GRAPHS</td>
<td>SYMBOLS</td>
</tr>
</tbody>
</table>

**Comments:**
Symbolic representation of data information and/or warnings.

### SYMBOLIC, SPATIAL

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAPS</td>
<td>PHOTOGRAPHS</td>
</tr>
<tr>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

**Comments:**
A representation of a message, a person, a scene or an area.

### CAD (Computer Aided Design)

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPUTER AIDED IMAGES</td>
<td>3D VIRTUAL IMAGES</td>
</tr>
</tbody>
</table>

**Comments:**
2 Dimensional and 3 Dimensional images created with the use of computer software.

### OTHER

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CROSSWORDS, PUZZLES</td>
<td></td>
</tr>
</tbody>
</table>

**Comments:**
Other miscellaneous visual images.
Dear (enter name),

The first round of discussions has proven to be very successful and valuable to this study. I’d like to thank you for your time and contribution so far. Your comments and feedback raised interesting questions. The taxonomy has been slightly modified after thorough study of the comments from all the participants. Some interesting references have also been proposed by some participants for further reading. Such contributions are also very valuable to this study and are highly appreciated, as it offers a great potential of extending this work to include a wider variety of traditions.

One area of concern raised referred to the difficulty of responding through the pdf format file that was initially sent out. For this reason, all documents have been created using Word document for the second round of discussions. Two documents are attached with this email:

1. Areas of concern raised and responses/actions
   An executive summary is provided summarising all areas of concern and actions taken towards these. A detailed discussion of those areas of concern follows.
2. Questions sheet 2

The modified taxonomy and the new area of discussion (cross-curricular links) are introduced. All relevant questions for both discussion areas (1 -The taxonomy & 2 Cross-curricula links) are also included.

My apologies for the short time allowed for responses. Due to time restrictions of the PhD programme of which this study is part; one week has been deemed the most appropriate time span, enabling us to engage in approximately 6 rounds of discussions. So, if your schedules permit, please fill in ‘Question sheet 2’ and send it back by the Friday, 4 March 2011.

Xenia Danos

---

Delphi group discussion 2: Cross-curricular links

The taxonomy was developed as a research tool, initially to be used for the gathering of empirical data. It has developed and has been modified over the past 30 months and therefore some differences might appear below (the taxonomy as used in 2009) to the proposed taxonomy in discussion 1. The cross-curricular textbooks analysis was carried out in 2009 using the taxonomy as the primary research tool. Three schools participated in the study. One in each of: Cyprus; UK; and the USA.

The study was focused on investigating the use of graphicacy in the curriculum. The following questions/aims of this study are depicted in the hierarchical order of significance for this study:

1. Is graphicacy used across the curriculum?
2. Which subject areas use graphicacy?
3. Which types of images are the most/least popular?
4. Are there any cross-curricular links of image use?
5. Which subject areas use the most/least variety of images?

Results from the study also indicated a number of teaching and learning purposes for which the images were used. These have been recorded incidentally and were not part of the initial scope of the study. The taxonomy was used in its 24+ categories format for this analysis, instead of 7 main-groups of categories. The latter format was used for the curriculum analysis due to the vague descriptions extracted from the documents. This enabled cross-curricular links to be clearly identified. The results focused on cross-curricular links concerning inbound (reading and understanding/decoding) graphicacy skills gathered from this study are illustrated in Figure 2.
Figure 2 Cross-curricular links concerning inbound graphacy skills

<table>
<thead>
<tr>
<th>Areas of graphacy</th>
<th>UK school</th>
<th>Cyprus school</th>
<th>USA school</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PICTORIAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Life drawing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landscape</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Portraits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Still life</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Drafts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sketching</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Drawing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Architectural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering/technical</td>
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<td></td>
<td>✓</td>
</tr>
<tr>
<td>Exploded</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Perspective</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Projections</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td><strong>SEQUENTIAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Story board</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flow diagram</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td><strong>SYMBOLIC</strong></td>
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</tr>
<tr>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
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<td>Charts &amp; graphs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Symbols</td>
<td></td>
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<tr>
<td>Maps</td>
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<tr>
<td>Photographs</td>
<td></td>
<td></td>
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<tr>
<td>Advertisements</td>
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<tr>
<td><strong>CGI</strong></td>
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<tr>
<td>CAD</td>
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<td></td>
</tr>
<tr>
<td>3D</td>
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<td></td>
</tr>
<tr>
<td>other</td>
<td></td>
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<td></td>
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</tbody>
</table>

X. Danos Ph.D. 2011
Appendices
Question 2: Do you think breaking up the taxonomy into 25 types of images was the appropriate method for a research tool to be used in the study described above?

Q2. Answer: Yes/ No
Q2. Comments:

Question 3: Is there anything within the results illustrated in Figure 2 which is unexpected?

Q3. Answer: Yes/ No
Q3. Comments:

Question 4: Do you think the cross-curricular links identified are equally appropriate for inbound and outgoing graphicacy skills (coding and decoding information)?

Q4. Answer: Yes/ No
Q4. Comments:

Question 5: Is there a difference between the level of difficulty in dealing with coding and decoding the same type of image?

Q5. Answer: Yes/ No
Q5. Comments:

Question 6: Do you think one can acquire outbound graphicacy skills (coding/creating an image) without having obtained the required inbound graphicacy skills (decode, read and understand information) relating to the same type of image?

Q5. Answer: Yes/ No
Q5. Comments:

Delphi group discussion 1 feedback – round 2: the taxonomy of graphicacy

Name:

Many interesting and valuable issues were identified and raised through the first round of discussions. An executive summary of these followed by a detailed discussion of the areas of concern raised are reported in the document titled ‘Feedback from Delphi Group discussion: round 1’. The taxonomy is considered to be a work in-progress; hence any appropriate modifications and/or additions can be included at any time. The changes made to the taxonomy based on the first discussion are presented below (Figure 1).

Question 1: Do you think version 2 of the taxonomy is a comprehensive and appropriate research tool for research in an educational context with regards to the types of images and the graphicacy skills (the ability to communicate [code & decode] information through still visual images) required to deal with them?

Q1. Answer: Yes/ No
Q1. Comments:
Figure 1

**A Taxonomy of Graphicacy**

By Danos Xenia, 2011 (version 2)

**Category description**

**PICTORIAL; WESTERN ART**

- Life Drawing
- Landscape
- Still Life
  - Representations from an individual artistic perspective.
  - Usually the item produced is a finished product itself.
  - To be decoded, the observer needs to interpret those images within the artist's cultural, educational or professional context.

**PICTORIAL; DRAWING**

- Drafts
- Sketching
- Drawing
  - Products finished to an appropriate level of accuracy to closely mirror an idea/observation.
  - This is often a means to achieve/get to the next stage.
  - To be decoded the observer needs to identify the idea/observation.

**PICTORIAL; DIAGRAMS**

- Perspective
- Architectural
- Engineering / Technical
  - Technical diagrams to define clearly features, details and/or requirements such as relationships, processes, components.
  - To be decoded, the observer has to have developed the relevant spatial abilities and understanding of the technique.

**SEQUENTIALL**

- Story Boards
- Flow Diagram
- Spider Diagram / Brainstorming
  - Images which illustrate the sequence of a thought, process or story.
  - Information follows a relative sense of direction.
  - To be decoded, the observer needs to be able to identify the flow of information.

**KEY**

- Newly added
- Removed
- Unaffected

**PICTORIAL: GRAPHIC ART**

- Images which help people visually explore and understand themselves and the world around them, how they respond or feel about it.

**PROJECTIONS**

- Orthographic
- Oblique
- Isometric

**SEQUENTIALL: LINEAL**

- Cartoons
### Symbolic; Quantitative/Abstract

**Charts & Graphs**
- Symbolic representation of data, information and/or warnings.
- To be decoded the observer must recognize and make connections between the data and/or information represented.

**Symbols**
- Representations of a message, a person, a scene or an area.
- To be decoded the observer must recognize and make connections between the messages represented.

### Symbolic; Spatial

**Maps**
- Representations of a message, a person, a scene or an area.

**Advertisements**
- To be decoded the observer must recognize and make connections between the messages represented.

### Photographic

**Photographs**
- Relating to photographs, especially representing or simulating something with great accuracy and fidelity of detail.
- To be decoded the requirements might include any of the above, but the capabilities required to create them depends on the hardware and software used.

### CAD (Computer Aided Design)

**Computer Aided Images**
- 2 Dimensional and 3 Dimensional images created with the use of computer software.
- To be decoded the requirements might include any of the above, but the capabilities required to create them depends on the software package.

**3D Virtual Images**
- Other miscellaneous still visual images.

### Other

**Games, Crosswords, Puzzles etc.**
Feedback from Delphi group discussion round 1

Executive summary

All responses and feedback from discussion 1 have been gathered, analysed and appropriate changes have been made to the taxonomy. The main matters (areas of concern) to be addressed are listed in an executive summary below (Table 1) and are described in further detail subsequently. A preview of the revised taxonomy is illustrated in Figure 1. Opportunities to comment on version 2 of ‘a taxonomy of graphicacy’ is provided in the attachment ‘Question Sheet 2’.

General comments

There has been a positive reaction towards the first discussion areas. The approach has been seen as ‘interesting and useful’, and ‘(also) because the taxonomy is, and should be a work in progress. This is an efficient way of gathering a variety of up-to-date views on the subject’. The ‘thrust of the categories is clear’ as ‘(it is) complete in terms of categories’ and the category description ‘explains the distinction between the categories’. Another area requiring further specification revolves around the images and categories used which are from the Western culture. This is because the research methodology (has been developed to) conduct (research) in the Western educational establishments. (In addition, a large quantity of the) literature about progression and development found has been Western. It is also apparent that a different ‘literature tradition’ is associated with the area of information design, which can add new insights to the research.

Table 1 Areas of concerns & responses

<table>
<thead>
<tr>
<th>Areas of concern</th>
<th>Response/ action</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Format of question sheets</td>
<td>A number of formats are now been trialled</td>
</tr>
<tr>
<td>12. Respond time-span</td>
<td>No change due to time restrictions</td>
</tr>
<tr>
<td>13. A hierarchy within the elements of the taxonomy</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>14. Why this taxonomy?</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>15. 24+ categories instead of 8 larger groups</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>16. Multi-layer meanings of an image</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>17. Tension between ARTS category and sub-categories</td>
<td>Taxonomy modified</td>
</tr>
<tr>
<td>18. Do spider diagrams have a direction of information flow?</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>19. What type of understanding is required to decode CARTOONS?</td>
<td>Taxonomy modified</td>
</tr>
<tr>
<td>20. Why are Charts &amp; Graphs grouped with Symbols?</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>21. Photographs; too prevalent to be grouped</td>
<td>Taxonomy modified</td>
</tr>
<tr>
<td>22. Which images are included in the CAD category?</td>
<td>Explained in the detail discussions area</td>
</tr>
</tbody>
</table>

Figure 1 Revised taxonomy of graphicacy (version 2)
Detailed discussions of the areas of concern from round 1

General comments
- A key has been added on the top right hand side to aid in identifying the changes made on version 2 of the taxonomy. In the final version of the taxonomy, no colour coding will be used at any point, and the key will be removed.
- The title ‘This category represents’ has been changed to ‘category description’ for succinctness. The descriptions under this section have been revised to be more precise and clear.
- Literature has clearly identified the possibility for all subcategories to be expanded further. For example, charts and graphs can be broken to specific types of charts – Gantt charts, pie charts, bar charts etc and specific types of graphs. Such information has not been added so far, because there has been no need yet within the scope of this research. It is within the near future plans for a sample of these to be added. This applies to all of the categories included in this taxonomy i.e. maps, diagrams etc.
- A number of new relevant references have been sent by a number of responders. Such contributions are also highly appreciated. A process to collect these and analyse them are currently in process.

Area of concern 1: Format of question sheets
The format of the question sheet has been identified as unsuitable for its purpose as it is difficult for the responders to ‘tick’ boxes and write comments on the pdf file. For this reason, pdf format files will be avoided for the question sheets; whenever possible MSWord or PowerPoint files will be sent out.

Area of concern 2: Respond time-span
The time allowed for the responses, both from the director and the participants of the group has been planned according to the time-plan of the PhD research programme, of which this study is part. The final submission of the thesis will be at end of June. The end of May will be the final time to collect new information and data as the last few weeks will be focused on final corrections, printing and binding the thesis. Therefore there are 12 weeks available for the Delphi group study which would allow for a maximum of 6 areas to be discussed. My apologies for the short time provided. Any contributions during this time are highly appreciated.

Area of concern 3: A hierarchy within the elements of the taxonomy
Definition of a taxonomy used for this study: The classification of images in an ordered system that indicates natural relationships; i.e. pictorial > diagram > projection > orthographic > ….

Area of concern 4: Why this taxonomy?
The images in the taxonomy have been grouped according to the type of understanding required to read and communicate (code and decode) the information though still images using in teaching and learning environments. A number of other authors’ work has been identified. The relevant ones have been analysed and joined together to create the taxonomy of graphicity (a relevant reference list is provided at the end of this document). Some of the taxonomies identified are based on different traditions, developed to serve different purposes. Blackwell & Engelhardt investigated 32 different image taxonomies and suggested 6 taxonomic dimensions ‘to taxonomise’ these. The 6 dimensions were: the representations; the message; relation between representation and message; task and process; context and convention; mental representation. The taxonomies representing education tended to relate to the taxonomic dimension of task and process (purpose), which was not the focus of this authors study. This research is based mostly on the types of images; taxonomic dimension one based on Blackwell & Engelhardt’s taxonomy (hence the specific understanding of decoding and coding information in certain ways). Danos’ taxonomy has been developed based primarily on Fry’s taxonomy. This was deemed the most appropriate existing taxonomy as it was developed by the images used within education. Hence, it was chosen as the main taxonomy to base the updated, new taxonomy of graphicity for the cross-curricular textbooks and curriculum analysis.
Area of concern 5: 24+ categories instead of 8 larger groups
The categories of the taxonomy were grouped according to the skills and abilities required to understand (code/decode) the information illustrated; i.e. pictorial diagrams to define clearly features, details and/or requirements such as relationships, processes, components. However, the taxonomy was used in its 24+ categories format instead of 7 main groups of categories during the cross-curricular textbooks analysis because the type of images (e.g. sketching) could be identified (Delphi group discussion area 2). This enabled cross-curricular links to be more clearly identified. During the analysis of the curriculum documents, the information identified was too vague and could therefore only be connected mostly with the wider groups of categories such as PICTORIAL or PICTORIAL > DRAWINGS etc.

Area of concern 6: Multi-layer meanings of an image
‘An image may fall under more than one category (by having) dual or even triple meaning’. This is recognised and acknowledged by this author. When dealing with images, this concept is acknowledged and referenced. Priority is given to the type of understanding required to first decode (read the information communication within) an image. For example, classic comic books would fall under the category of PICTORIAL > WESTERN ART > OTHER COMPOSITIONS and SEQUENTIAL > STORY BOARDS.
For example, symbols can potentially be partly pictorial or abstract images but the skills and abilities required for one to read, understand and create these are primarily based on symbolic representations, i.e. when referring to a sign (Figure 2), that would include the shape of the sign, border line, background colour and symbol or illustration.

Figure 2 Examples of signs using symbolic representations

Area of concern 7: Tension between ARTS category and sub-categories
The category of PICTORIAL; GRAPHIC ART has been changed to PICTORIAL; WESTERN ART. It was identified through the first discussion that the general term used in UK currently, for Graphic Art involves images such as posters, CD covers and other marketing images. Based on the description of the category, it was recognised that the tradition described was of the (Western) art (as it is ‘expressing personal, social, religious and/or cultural ideas’).
The subcategory in this section, previously named ART has now been changed to OTHER COMPOSITIONS. As mentioned before, the term ART can be very complicated and misleading due to the wide range of meanings it has within modern western culture. The subcategory itself is a varied and complex area, which includes all types of expressive compositions such as cartoons, abstract, surreal, doodles etc.

Area of concern 8: Do spider diagrams have a direction of information flow?
Figure 3 illustrates the type of direction of information flow a spider diagram follows, which can, however, ‘indicate a more complex relationship [than lineal]. This direction of flow doesn’t follow a lineal way. For this reason, the title of the category has been re-considered; to remove the word LINEAL and keep the title of ‘SEQUENTIAL’

Figure 3 Spider diagram direction of flow of information
Issue 9: What type of understanding is required to decode CARTOONS?
CARTOONS is a category under review at the moment, as it certainly does not have to be sequential to deliver a message (as illustrated by the example used in the 1st version of the taxonomy of graphicacy). It can be consider as an element within the PICTORIAL > WESTERN ART > OTHER COMPOSITIONS as often the image is heavily influenced by the artists’ cultural, religious, political, professional and educational contexts.

Area of concern 10: Why are Charts & Graphs grouped with Symbols?
Both types of images use symbolic representations to communicate the information, even though one is communicating quantitative and the other abstract information. This is seen from the aspect that numbers are numerical representations of quantity, size, speed etc.

Area of concern 11: Photographs; too prevalent to be grouped
After a lot of reviews and comments over the last few years on the category of photographs, it has been decided to move the category to be on its own as it was deemed to ‘deserve their own category as they are so prevalent’.

Area of concern 12: Which images are included in the CAD category?
Computer-aided design may include all of the above categories. From an incoming (reading) perspective, similar skills are likely to be required as above. From an outgoing (creating or applying) perspective, the skills required will depend on the sophistication and complexity of the software package used.

References (need final formatting)
Angela A., 1997, Drawing out Ideas: Graphicacy and young children
Aldrich F& Sheppard L (2000) ‘Graphicacy’: the fourth ‘R’? Primary Science Review, 64, 8 – 11
Balchin W and Coleman W (1965) Graphicacy should be the Fourth Ace in the Pack, Times Educational Supplement, November 5, 3 (1), 23-28
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Boardman D., 1983, Graphicacy and Geography teaching, Croom Helm, London;
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Considine, D., 1987, Visual literacy and the curriculum: More to it than meets the eye. Language Arts, 64, 634-640, October.

Liben S. L. & Downs M. R., 1993, Understanding Person-Space– Map relations: Cartographic and Developmental Perspectives, Developmental Psychology, 29(4), 739—752


The Associated Examining Board (1984) Test in basic graphicacy


Wilmot, P.D., 1999, Graphicacy as a Form of Communication, South African Geographical Journal (special Issue June) 81 (2), 91-95


Round 3 letter for discussion

Dear (enter name),

Please feel free to join in the Delphi Group now, even if your schedule prevented you commenting in Rounds 1&2.

The feedback and comments received on the work completed so far has been very helpful and valuable. A number of important areas have been recognised which could be strongly recommended for future work. These have been identified within the attachment ‘Areas of concern raised and responses/ actions’. In the same document, the taxonomy is presented following a further modification after thorough reflection and contemplation of the comments received.

Three documents are attached with this email:
3. Areas of concern raised and responses/ actions
An executive summary is provided summarising all areas of concern and actions taken towards these. An area of the taxonomy was renamed. This is identified and presented here. A detailed discussion of the areas of concern follows.
4. Delphi group discussion 3 Rendering descriptors
The new area of discussion on drawing a descriptor list relating to rendering is introduced.
5. Questions sheet 3

All relevant questions to this round of discussions are presented.

I would like to thank all the participants so far for your time and valuable advice and comments on the matters raised for discussion. If your schedules permit, please fill in ‘Question sheet 3’ and send it back by the Friday, 18 March 2011.

Xenia Danos

Delphi group discussion 3: Rendering descriptors

In South Africa, considerable work has been conducted on graphicity, primarily by Wilmot and her research students. Tests on elements of graphicity were developed and conducted with primary and secondary school students. The tests were seeking to identify the spatial skills and necessary combinations of these needed for dealing with both coding and decoding information. The results of these studies indicated, amongst other findings, that within a specific age group, children of the same age, while tending to utilise the same skills, do so in different combinations and at different levels of sophistication. The findings supported the notion that spatial perceptual and conceptual development, are age related. At the same time, the findings challenged the notion that spatial understanding is dependent on an innate and unfolding process of development which follows an invariable sequence. The results follow Matthew’s (1992) and Spencer’s (1995) findings which suggest that the child’s capacity to structure, organise and communicate spatial information is often overestimate and taken for granted. It was also revealed that the group of children involved within this study were able to utilise most of the skills and combinations of skills at a consistently high level of competency.

The list below (Table 1) reports the main skills investigated through the above tests which were designed as practical or mapping (drawing) tasks.
A different skill often requiring to be utilised while creating a number of different types of images, such as the ones under the categories of drawings and western art (Danos taxonomy), amongst others, is rendering. To successfully render shapes, an understanding of spatial elements such as shape, depth, and distance etc is required, as well as elements such as texture, light source etc.

Rendering was identified as a common area of study (amongst others) for the 24 students, aged 14-15 years old (GCSE level) who volunteered to take part in a study (Danos et al, 2010). This study was treated as a pilot study, testing out the methodology, design of tasks and analysis of results, with the final aim of generating continuity and progression descriptors when utilising the key competences when rendering. The various techniques used for different media were not included within the scope of this study.

Areas of focus for the pilot study:
The pilot study was designed around the competency levels and relevant common areas of study of the students. The group was very diverse in terms of abilities, background and curriculum areas of focus. In total there were 24 Year 10 students brought together from the areas of Art and Design, Resistant Materials, Graphic Products, and Product Design. The students were described by their teachers as generally ‘having behavioural problems, 8 of them having the drawing skills of 5 year olds, 5 of them were considered gifted and talented in drawing and 3 didn’t speak English’. After consulting experts from Loughborough University and the students’ teachers, it was decided to aim the activities at an initial base level and provide extension tasks which would allow the students to show progression and continuity of their knowledge and competencies.

Table 2 shows the common context identified by analysing AQA syllabuses and past papers in the four subject areas. These consisted the areas of study of the visiting students.
Table 2 Common areas of study between the syllabuses

Table 3 shows the selected tasks from these common areas of study as defined by the taxonomy of graphicacy (as developed and used at that time) which has been developed from prior research.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Areas of graphicacy</th>
<th>Type of image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rendering material surfaces</td>
<td>Pictorial</td>
<td>(one element of) Drawing</td>
<td>Well finished products that closely mirror an idea or observation</td>
</tr>
<tr>
<td>2 point perspective</td>
<td>Pictorial</td>
<td>Diagram</td>
<td>Technical diagram to clearly define features, details and/or requirements</td>
</tr>
<tr>
<td>Logo design</td>
<td>Symbolic</td>
<td>Abstract</td>
<td>Symbolic representation of information and warnings which convey messages/ ideas</td>
</tr>
</tbody>
</table>

Table 3 Pilot study tasks

Pilot study methodology

Workshop implementation
The pilot study workshop lasted for 2 ½ hours. The students were provided with booklets which contained all the handouts and worksheets in the appropriate order, 2 different coloured pencils and one writing pencil. Students were shown how skills similar to the ones they were to be taught that day were used in industry and developed at university level. The rest of the workshop time was divided into three sessions as shown in Table 3. The sessions on rendering and logo design ran in a similar manner (Figure 1).
4. Students were asked to complete a task before any teaching occurred. Students were told what to do but not how to it.
5. A lesson with PowerPoint slides and live demonstrations was run. Students had the opportunity to practise what was being learned by completing various tasks. The ratio between adults to students was approximately 1:3 which meant students had a lot of constant support during the lesson.
6. At the end of each lesson, students were asked to complete by themselves the same task they had completed in the beginning of the lesson.

By the end of the sessions, the aim was to obtain a record of each student’s level and knowledge in each area prior to, during and after the lesson.
Lesson configuration method

The focus of the rendering tasks (Figure 1) was on the ability to colour-in realistically, basic shapes, taking into consideration the direction of a light source. Figure 2 illustrates the stages of the lesson. Table 4 shows the initial generic criteria that were developed to assess the above work. The criteria were developed having reviewed common textbooks and teaching and learning resources in relation with the above tasks. This was a starting point to assess students’ work with the expectation that these would be developed further through the analysis of the results collected.
Figure 2 Rendering: Stages of the lesson

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Level descriptors</th>
</tr>
</thead>
</table>
| Rendering | • Difference shown in shading between the faces  
| | • The faces closer to the light source are lighter in colour  
| | • A gradient of colour used on each face to give a more 3D effect  
| | • Shadow added towards the opposite side of the light source |

Table 4 Generic criteria developed as initial level descriptors

Data analysis method
The pilot study provided strong evidence towards a useful strategy for this research. The work conducted with the group of students and the analysis of their work brought to light further detailed requirements on each level descriptor which resulted in more detailed descriptors lists. These lists were developed as students’ work was being assessed (Figure 3).
Figure 3: Task: Breaking down the list of descriptors

<table>
<thead>
<tr>
<th>Criteria used to evaluate the task</th>
<th>Task 1</th>
<th>Task 2</th>
<th>Task 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference shown in shading between the faces</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>The faces closer to the light source are lighter in colour</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>A gradient of colour used on each face to give a more 3D</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>effect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shadow added towards the opposite side of the light source</td>
<td></td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

Taking as an example the first student, it is clear that the checklist does not provide enough details to distinguish the level between the 3 pieces of work. New points can be added to the specification list.

- Taken from task 1:
  - All visible surfaces coloured in using the correct shade.
  - All visible surfaces coloured in using the correct gradient.
  - Identify a light source.
  - Shading should suggest the correct form/shape of the object

- Taken from exercise 1:
  - Shading to suggest a specific finish i.e. wood, matt, shiny

- Taken from task 2:
  - 
  - 

- Taken from task 3:
  - 
  - 

### Rendering list descriptors

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
</table>

#### Identify a light source

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
</table>

#### Rendering

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
</table>

All visible surfaces coloured-in

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
</table>

All visible surfaces coloured-in applying a gradient

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
</table>

All visible surfaces coloured-in using the correct\(^3\) gradient

---

\(^3\) lighter colour near the light source, darker colour as it gets further away
Gradient of colour applied correctly, in a smooth form where appropriate

- Shading the object to suggest the correct form/shape
  (Cylinder: shading to follow a long vertical lines running across the length of the form. Cone: shading to follow triangular shaped or long lines from the tip to the base. Sphere: shading to follow circular diameters. Cube: shading blending uniformly for a matt finish)

Shading drawn to suggest metallic finish by creating clearly/distinctly/sharply different areas of light, ranging from white/nude to black/dark

Shading drawn to suggest wooden finish by drawing wood grains in the appropriate directions (lines connecting on at least 2 edges for cuboids)

Shading drawn to suggest matt finish by blending the edges of the different areas of lights

Shadow
Shadow added

Shadow added at the correct direction

Shadow added to suggest the correct form of the shape

Shadow added correctly\(^4\) according to the distance of the light source, suggesting the correct form of the shape

\(^4\) Drawing 2 lines passing through each corner of the box. One extends from the light source, the other is either parallel lines or from a vanishing point if using perspective. Where lines from the same vertical plane (of the object) intersect, is the point the shadow will reach.
Refined final descriptors for rendering; drawn after further reflection subsequent to analysis.

To whom it may concern; ADDITIONAL INFORMATION

During the analysis of the students’ work the level descriptors were developed, and a more detailed list of descriptors emerged. (These were later refined as shown in pages 6-9 of this document). A sample of the analysis for one student is show in Table 5.

<table>
<thead>
<tr>
<th>Rendering list descriptors</th>
<th>Students’ work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tasks</td>
</tr>
<tr>
<td></td>
<td>1a</td>
</tr>
<tr>
<td>Identify a light source</td>
<td>/</td>
</tr>
<tr>
<td>Rendering</td>
<td></td>
</tr>
<tr>
<td>All visible surfaces coloured in using the correct tone</td>
<td>/</td>
</tr>
<tr>
<td>All visible surfaces coloured in using the correct gradient</td>
<td>/</td>
</tr>
<tr>
<td>Gradient of colour applied in a smooth form where appropriate</td>
<td>/</td>
</tr>
<tr>
<td>Shading to suggest the correct form/shape of the object</td>
<td>/</td>
</tr>
<tr>
<td>Shading drawn to suggest a specific finish i.e. wood, matt, shiny</td>
<td>n/a</td>
</tr>
<tr>
<td>Shadow</td>
<td></td>
</tr>
<tr>
<td>Shadow added</td>
<td>/</td>
</tr>
<tr>
<td>Shadow added at the correct direction</td>
<td>/</td>
</tr>
<tr>
<td>Shadow coloured in using a gradient</td>
<td>/</td>
</tr>
<tr>
<td>Shadow coloured in using the correct gradient</td>
<td>/</td>
</tr>
<tr>
<td>Shadow added to suggest the correct form of the shape</td>
<td>/</td>
</tr>
<tr>
<td>Shadow added correctly according to the distance of the light source</td>
<td>/</td>
</tr>
</tbody>
</table>

Table 5 Rendering: students’ work analysis

Results on rendering tasks
Figure 4 illustrates the rate of success each student had on every task completed on rendering. It is clear that students performed best during the class exercise while working along with the adults, as that is the task all students completed with the most success. From the results of this pilot study, there are some indications of progression that students had gained in their skills and understanding of rendering. This is shown by the number of students who showed improvement (11/24). A small number scored less in the last task (4/24) and some showed no difference (9/24). Seven students did not manage to score any points for the first task, and four of those students showed improvement by 10% - 20% in the last task. The scores of the rate of success of the students on the developed descriptors list for rendering have been normalised out of 100 to give a fair comparison
Figure 4 Rendering: students’ rate of success per task

Figure 5 indicates a progression amongst the descriptors. As an initial stage the descriptors were placed in an assumed level of difficulty. This was later validated by the rate of success each task had. The most commonly completed descriptors tend to be within the first skills one gains while learning how to render correctly, such as identifying the light source and using the correct tone to colour in each visible surface of a shape. Correctly adding the shadow according to the distance of the light source seems to be the most difficult of the tasks described here.

Figure 5 Rendering: rate of successfully completed descriptors

The descriptor which appears to be out of the anticipated order in the progression of the stages is related to shading to suggest a specific finish. This might be more straight-forward than initially determined, but it was also a key area of focus within the teaching and learning in the session, unlike adding a shadow for example.
References


Spencer, Ungar & Blades, 1995, Mental rotation of a tactile layout by young visually impaired children, *Journal (Paginated), Department of Psychology, University of Sheffield.*

Van Harmelen, Primary Teachers and Science and Technology – The Role of Graphicacy in an In-service Programme for South Africa Teachers.


Questions sheet 3

Delphi group discussion 3: Rendering descriptors

Name:

The area of focus of the PhD has been on identifying descriptors of outbound (coding information) skills related to graphicacy elements.

Questions 1: Is the methodology presented in the attachment ‘Delphi group discussion 3 Rendering descriptors’ of gathering data within practice, appropriate?

Q1. Answer: Yes/ No
Q1. Comments:

Questions 2: Could this research strategy develop an understanding of progression in this element (rendering) of graphicacy?

Q2. Answer: Yes/ No
Q2. Comments:

Questions 3: Do you think the descriptors generated would be useful during assessment for learning relating to rendering?

Q3. Answer: Yes/ No
Q3. Comments:

Questions 4: This is the final list of descriptors. Would you add, remove or change the order of any of them?

1. Identify a light source
2. All visible surfaces coloured-in
3. All visible surfaces coloured-in applying a gradient
4. All visible surfaces coloured-in using the correct\(^5\) gradient
5. Gradient of colour applied correctly, in a smooth form where appropriate
6. Shading to suggest the correct form/shape\(^6\) of the object
7. Shading drawn to suggest metallic finish by creating clearly/distinctly/sharply different areas of light, ranging from white/nude to black/dark
8. Shading drawn to suggest wooden finish by drawing wood grains in the appropriate directions (lines connecting on at least 2 edges for cuboids)
9. Shading drawn to suggest matt finish by blending the edges of the different areas of lights
10. Shadow added
11. Shadow added at the correct direction
12. Shadow added to suggest the correct form of the shape
13. Shadow added correctly\(^7\) according to the distance of the light source, suggesting the correct form of the shape.

Q4. Answer: Yes/ No
Q4. Comments:

Additional/ general comments:
Feedback from Delphi group round 2 discussion

Executive summary

All responses and feedback from discussion 2 have been gathered, analysed and appropriate responses have been drawn. The main matters (areas of concern) to be addressed are listed in an executive summary below (Table 1) and are described in further detail subsequently. A preview of the revised taxonomy is illustrated in Figure 1. Opportunities to comment on the results of round 2 and the next matter raised for this group; ‘rendering descriptors’ is provided in the attachment ‘Question Sheet 3’.

General comments

The second round of discussions provided more positive reactions, useful comments and points for further thought and development. The changes made to the taxonomy ‘definitely improved the taxonomy, showing the value of the Delphi process’. ‘Version 2 of the taxonomy is in a much better shape and more understandable due to the new information that has been incorporated’. It has been agreed by a number of participants that ‘this is work-in-progress’, being refined by ‘following several times its repetitive nature’. The intended use of the taxonomy forms an important statement to be incorporated within the table illustrating the taxonomy. This along with a modification relating the symbolic – advertising category have been changed (Figure 1). A lack of important information relating to the study described in round 2 was identified. I offer my apologies for this. The information has been added in the detailed discussion section of this paper to better explain the context and method of the cross-curricular links of image use between subjects. It should also explain the selection of the subject areas within each school.

The approach of the 25+ categories within the taxonomy was found to be ‘very informative’. ‘Having a broad range of types makes it possible to reflect the complexity and specificity of the curriculum’. Depending on the research focus the taxonomy is used for, each category (element of graphicacy) can be extended to be more specific. The inter-rater reliability of the

\(^5\) Lighter colour near the light source, darker colour as it gets further away

\(^6\) Cylinder: shading to follow a long vertical lines running across the length of the form. Cone: shading to follow triangular shaped or long lines from the tip to the base. Sphere: shading to follow circular diameters, Cube: shading blending uniformly for a matt finish.

\(^7\) Drawing 2 lines passing through each corner of the box. One extends from the light source, the other is either parallel lines or from a vanishing point if using perspective. Where lines from the same vertical plane (of the object) intersect, is the point the shadow will reach
taxonomy was raised, an area which was tested numerous times over the course of this research, but with limited data gathered. More information on this area is provided in the detailed discussion section. A number of different views have been expressed relating to acquiring knowledge for coding and decoding information, and levels of difficulty related to those. These are described in more detail in the next section.

Towards the end of the first year of the study, it became evident that there were 4 potential areas of focus:

- Pursuing further the patterns of image use across the 3 schools;
- Work on the taxonomy of graphicacy to develop it as a research tool to be used by independent researchers;
- Identify continuity and progression descriptors for inbound (decoding information) graphicacy skills;
- Identify continuity and progression descriptors for outbound (coding information) graphicacy skills.

The last area listed above was chosen as the main focus for this study.

<table>
<thead>
<tr>
<th>Areas of concern</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All advertising media in the form of still images should be included in the</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>taxonomy</td>
<td></td>
</tr>
<tr>
<td>2. Appropriateness and comprehension of version 2 of the taxonomy</td>
<td>75% - Yes</td>
</tr>
<tr>
<td></td>
<td>25% - Yes (considering it is a work in process)</td>
</tr>
<tr>
<td>3. Insufficient information provided about the study</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>4. Is the methodology of 25 groups of images appropriate?</td>
<td>100% - Yes</td>
</tr>
<tr>
<td>5. Does the taxonomy as a research tool offer inter-rater reliability?</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>6. Are any cross-curricular links unexpected?</td>
<td>80% Yes</td>
</tr>
<tr>
<td>7. Why isn’t there a uniform match of subject areas analysed from each school?</td>
<td>Explained in the detail discussions area</td>
</tr>
<tr>
<td>8. Are the cross-curricular links indentified equally appropriate for coding and</td>
<td>60% answered; No</td>
</tr>
<tr>
<td>decoding information?</td>
<td></td>
</tr>
<tr>
<td>9. Is there a difference between the level of difficulty in dealing with coding</td>
<td>100% Yes</td>
</tr>
<tr>
<td>and decoding the same type of image?</td>
<td></td>
</tr>
<tr>
<td>10. Can one acquire outbound graphicacy skills without having obtained the</td>
<td>80% No</td>
</tr>
<tr>
<td>required inbound graphicacy skills?</td>
<td>20% Unsure</td>
</tr>
</tbody>
</table>

Table 1 Areas of concerns & responses
# A Taxonomy of Graphicacy

By Danos Xenia, 2011 (version 3)

The taxonomy was designed for use in research of still image use within an educational context

## Category description

### PICTORIAL; WESTERN ART

- **LIFE DRAWING**
- **LANDSCAPE**
- **STILL LIFE**

- Representations from an individual artistic perspective.
- Usually the item produced is a finished product itself.
- To be decoded, the observer needs to interpret these images within the artists’ cultural, educational or professional context.

- **PORTRAITS**
- **OTHER COMPOSITIONS**

### PICTORIAL; DRAWING

- **DRAFTS**
- **SKETCHING**
- **DRAWING**

- Products finished to an appropriate level of accuracy to closely mirror an idea/observation.
- This is often a means to achieve/get to the next stage.
- To be decoded the observer needs to identify the idea/observation.

### PICTORIAL; DIAGRAMS

- **PERSPECTIVE**
- **ARCHITECTURAL ENGINEERING / TECHNICAL**
- **EXPLODED**
- **PROJECTIONS**

- Technical diagrams to define clearly features, details and/or requirements such as relationships, processes, components.
- To be decoded, the observer has to have developed the relevant spatial abilities and understanding of the technique.

### SEQUENTIAL

- **STORY BOARDS**
- **FLOW DIAGRAM**
- **SPIDER DIAGRAM / BRAINSTORMING**

- Images which illustrate the sequence of a thought, process or story.
- Information follows a relative sense of direction.
- To be decoded, the observer needs to be able to identify the flow of information.

### SYMBOLIC; QUANTITATIVE/ ABSTRACT

- **CHARTS & GRAPHS**
- **SYMBOLS**

- Symbolic representation of data, information and/or warnings.
- To be decoded the observer must recognise and make connections between the data and/or information represented.
After further consideration and though following the second round of discussion on the taxonomy, another small change has been made regarding the category of advertising. This has now been placed under the main titles of ‘SYMBOLIC; QUALITATIVE’, named ‘ADVERTISING MEDIA’ to clearly include such images as business cards, posters, leaflets and other still advertising images.
Detailed discussions of the areas of concern that arose

General comments

- All participants agreed that the revised version of the taxonomy is a comprehensive and appropriate research tool for research in an educational context with regards to the types of images and the graphicacy skills (the ability to communicate [code & decode] information through still visual images) required to deal with them.
- All participants agreed that breaking the taxonomy into 25 types of images was the appropriate method for a research tool to be used in the cross-curricular textbooks analysis.
- Most participants (80%) found some unexpected results in the cross-curricular image use.
- All participants agree that there is a difference between the level of difficulty in dealing with coding and decoding the same type of image
- ‘Coding and decoding are bound together in practice and in the brain. This is an area which requires further inquiry. Currently cognitive science is showing that the same part of the brain deals with coding and decoding. A study of children’s early drawings shows an extraordinary binding together of mark-making and meaning-making. Children use marks in ways which are generally ‘emergent’ - the same marks being emergent drawing (a circle for a head) and emergent writing (a circle for the letter O or zero’.

Area of concern 1: capturing a wide range of different types of images related to each element of graphicacy

It has been suggested that a number of different examples should be provided under each element of graphicacy, to illustrate the wide range of variations which could exist. This is a point taken under consideration for near-future work. However, the break-down of the elements could differ according to the context of the research study the taxonomy is used for. Nevertheless, a second version of the taxonomy might be developed incorporating a sample of these. The existing taxonomy will not be expanded to include these as it is based on the idea that images are grouped around the type of understanding required to code or decode the information illustrated. Adding a number of advertising media or different photography images, for example, is not deemed necessary as the understanding in creating or reading the message/information from such images is too similar for each type to be represented individually in the taxonomy. The layout and perhaps the purpose specification might differ slightly, but the overall skills required to understand how to decode or code the information within these, are shared between all of them.

Area of concern 2: does the taxonomy offer inter-rater reliability as a research tool?

The inter-rater reliability of this research tool has been tested several times over the past 26 months. A number of opportunities to do this were found through workshops with approximately:

- 30 PGCE (Postgraduate Certificate in Education) students from Loughborough university in 2009
- 25 teachers acting as PGCE mentors in 2009
- 120 PGCE and Masters degree level students from Sheffield Hallam University in 2009
- 30 academics and researchers during a workshop on co-research at the Design And Technology Association Conference 2010
- 80 PGCE students from Sheffield Hallam University in 2011

For all of the above sessions, an analysis of the taxonomy was first delivered, followed by an exercise. All participants were given a handout with 25 images printed in front of them (Figure 3), and the table listing the areas of the taxonomy as it was (Figure 4). In groups or individually the participants were asked to identify under which category or categories each image lies. In addition, they were asked to identify the Design and Technology subject area it was from, i.e., electronics, food technology, resistant materials etc. The workshops and seminars were run in the UK, in English. The images used for the exercise were taken from
within Greek contexts, and therefore participants had to rely exclusively on their graphicacy skills to identify each type of image.

### Task 1
Images taken from various DT subject areas. They are in Greek! Have a guess at the type of image and the subject area they are from. Complete the table on page 4.

<table>
<thead>
<tr>
<th>No.</th>
<th>Image Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Instructions</td>
</tr>
<tr>
<td>2.</td>
<td>The digestive system</td>
</tr>
<tr>
<td>3.</td>
<td>CD rack</td>
</tr>
<tr>
<td>4.</td>
<td>Patterns</td>
</tr>
<tr>
<td>5.</td>
<td>Alarm system</td>
</tr>
<tr>
<td>6.</td>
<td>Poster</td>
</tr>
<tr>
<td>7.</td>
<td>Material location</td>
</tr>
<tr>
<td>8.</td>
<td>Nutritional information</td>
</tr>
<tr>
<td>9.</td>
<td>Textiles</td>
</tr>
<tr>
<td>10.</td>
<td>Cabinet</td>
</tr>
<tr>
<td>11.</td>
<td>Rendering</td>
</tr>
</tbody>
</table>
Figure 3 List of images provided for the exercise
**Subject Areas Vs Types Of Images matrix**

Identify the type of each image and write the relevant number in the table below

<table>
<thead>
<tr>
<th>GRAPHIC ARTS</th>
<th>Resistant materials</th>
<th>Graphic products</th>
<th>Electronic products</th>
<th>Textiles</th>
<th>Food technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Life drawing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Still life</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portraits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landscape</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|PICTORIAL    |                     |                  |                    |         |                 |
|DRAWINGS     |                     |                  |                    |         |                 |
|Drafts       |                     |                  |                    |         |                 |
|Sketching    |                     |                  |                    |         | 3               |
|Drawing      |                     |                  |                    |         |                 |

|DIAGRAMS     |                     |                  |                    |         | 2               |
|Annotated    |                     |                  |                    |         |                 |
|Architectural|                     |                  |                    |         |                 |
|Exploded     |                     |                  |                    |         |                 |
|Engineering/Technical| | | | | |
|Projections  |                     |                  |                    |         |                 |
|Perspective  |                     |                  |                    |         |                 |

|SEQUENTIAL  |                     |                  |                    |         |                 |
|Cartoons    |                     |                  |                    |         |                 |
|Storyboards |                     |                  |                    |         | 1               |
|Flow diagrams |                 |                  |                    |         |                 |

|SYMBOLIC    |                     |                  |                    |         |                 |
|ABSTRACT    |                     |                  |                    |         |                 |
|Charts & Graphs |           |                  |                    |         |                 |
|Symbols     |                     |                  |                    |         |                 |

|SPATIAL      |                     |                  |                    |         |                 |
|Maps         |                     |                  |                    |         |                 |
|Photographs  |                     |                  |                    |         |                 |
|Advertisements|                     |                  |                    |         | 1               |

|CAD |                     |                  |                    |         |                 |
|Computer Aided Design | |                  |                    |         |                 |
|3D virtual images |                     |                  |                    |         |                 |

**NAME:** .................................................................................................................

Figure 4 The taxonomy of graphicacy in a table from

The taxonomy has also been used by a people during co-research (2009, 2010) and it has been referenced and used as an analysis tool by other researchers (i.e. Cheng Beh, Loughborough University research student).
It is important for the user to understand that one image might fall under 1 or more categories from the taxonomy. One example would be when creating a step-by-step visual guide on how to render a form using coloured pencils to suggest a matt finish. The person creating the guide will have to have an understanding of how drawings or sketches are created (to be able to code information in this manner). Additionally, the knowledge and understanding of creating sequential images might be required to produce the step-by-step guide. A different example is shown in Figure 5. For one to be able to create such an image as the poster illustrated below one has to have a clear understanding of how to create a drawing (Pictorial category). Knowing how to create posters to communicate a message is also very important (Symbolic category).

Sometimes images might wrongly appear from a first glance to fit in the above description. The image below (Figure 6) for example, illustrates a strong man that has for a shield all the nutritious types of food, and he is chasing away a ‘bad/evil’ little green creature; bacteria and diseases. This is in a drawing form or media, but one only needs to be able to understand (decode) symbolic representation to understand the image.

The discussion within round 2 brought to the surface a need for quantitative empirical evidence on the use of the taxonomy by others. During the workshops and seminars conducted so far validating the inter-rater reliability of the taxonomy as a research tool, completed worksheets were only retained from the D&T Association conference workshop. These worksheets were completed by experienced teachers and researchers and can be analysed to indicate inter-rater reliability. However, no issues were raised at the time by the participants who supported the possibility of co-research using this tool. The second Sheffield Hallam session with PGCE students was video recorded and this will be reviewed for further evidence. If necessary, this exercise could be repeated in the near-future. It will certainly be a strong recommendation for future work.

**Area of concern 3: Insufficient information provided regarding the study**

Important information of this study were not included in the letter I sent out, for which I send my apologies. The descriptions of the 3 schools the study took place at, as well as the method used to select the textbooks and gather the information is provided below:

**School Descriptions**

Cyprus schools description: The school in Cyprus used for the pilot study is a typical lower government founded, mixed school. Students are aged 11-14 years old. All subjects are compulsory at these levels. The school is in an area considered to be middle-to lower-class, and the students and most teachers live locally to the school. Teachers in Cyprus are relocated every three to five years. Despite this a few teachers have been in this same school for the past eight to ten years. In Cyprus, the textbooks are provided free from the government. It is therefore safe to assume that the types of information gathered from the
textbook analysis and the informal interviews is a true representation of how graphicacy is used in the majority of secondary schools in Cyprus. In most subject areas, there are 31 to 33 students per class.

USA School Description: The school in the USA was very different to the one in Cyprus. This school was a private, mixed school with very high annual fees (ranging from $20,000 - $33,000 annually). Students from this school are expected to go on to higher education, with a high percentage of students entering Harvard, Oxford, Cambridge, or other universities of a similar status. Teachers in this school usually do not leave unless they retire. For this reason, most teachers have been in this school for more than 5 years. The school is divided into lower, middle, and upper schools, with 330, 175, and 480 students, respectively. In total, there are 985 students. The teacher-student ratio is 8:1. The survey was conducted in the upper school, which deals with years 9 to 12 (ages 14/15-18/19). The textbooks used in the lessons are chosen by the individual teachers. A different set of books could be chosen by the same teacher each academic year.

UK School Description: School C is a Local Education Authority (government funded), lower school with high achieving students ranging between 11-14 years old. Teachers are actively involved in constantly upgrading their schemes of work, which has awarded them an “outstanding” achievement for their curriculum from the recent (English) Office for Standards in Education (OFSTED) report. In most subject areas there are approximately 30 students per class. The textbooks used in this school are selected by each department. They are usually based on the criteria of the assessment board each department is working with.

Methodology
The main methodology used for this study was opportunistic. The schools were chosen based on their acceptance and volunteering to take part in this study. The subject areas studied were chosen in the same way. For this reason, it was not possible to analyse textbooks from the same subject areas across all 3 schools. At the time, that was not seen as a problem, as the main aims of the study in order of priority were:

- to identify if graphicacy was used across the curriculum;
- to identify the most and least popular types of images used;
- to identify any cross-curricular links.

The main textbooks used for various subject areas were gathered, analysed from cover-to-cover, and photographic evidence was taken. The context of each image was also noted by photographing the text that was included related to the image. Although the text was not part of the study, it was important to have the context the image related to. This helped in identifying the type of image, as often 2 or 3 categories could describe the image if the context it was in wasn’t known. Informal, interviews were conducted with the relevant teachers, to ensure all evidence collected was indeed used at least once in their lessons.

The following subject areas were analysed:

- Cyprus: biology, physics, chemistry, mathematics, Greek language, languages, history, geography, design and technology, art, information technology, music and religious studies.
- USA: biology, chemistry, calculus, geometry, languages, history, information and communication technology and art.
- UK: science, mathematics, English language, French language, geography, religious studies and design and technology.

A comparative graph was drawn, mapping all types of images as used in Cyprus, USA and UK.

The number of times each category of image occurred was normalised to a scale of 10 because of the variation in the number of subjects surveyed (Cyprus 13, USA 8, and UK 7 subject areas). The table is colour coordinated according to the categories of the taxonomy. Information is illustrated using the bars, the colours, and the lines joining the results together. Although the results were originally mapped to simply identify the most and least popular type images, a clear pattern between the popularity of the types of images across the three schools appeared. The most and least popular images used across the curriculum in USA, seemed to also be amongst the most and least popular images used in Cyprus and the UK (Figure 7). For example, photographs seem to be used by most subjects surveyed in all three countries, whereas draft drawings did not appear to be used at all. The patterns that emerged
of image use were found to be so interesting and unexpected at the time, which threatened to shift the focus of the entire PhD research (it was identified within the first 3 months of the research). It is definitely an area to be recommended for future work.

**Area of concern 4: Curriculum map has subjects missing**

It would have been ideal to study the same subject areas in all 3 countries. Some of the issues which prevented that from happening included:

- not all subjects were the same across the 3 schools (such as the different areas of mathematics, ICT, DT and RE taught in the 3 countries).
- teachers’ approval and support was required for each subject area’s textbooks to be analysed.
- time restrictions, as the time I was given permission to work with the schools was limited.
- Not all subjects used textbooks during teaching (this research was based on textbooks analysis)
- It was not a required to answer satisfactory my research questions set at the time (as listed above on page 10 under the section of methodology).

**Area of concern 5: limited involvement of a variety of graphicacy elements and Art**

One explanation that can be offered for this phenomenon could be due to the vague Cypriot national curriculum guidelines offered for the subject of art, as it can often lead to poor teaching schemes. My observation for the USA and Cyprus schools is that the art as a subject was not valued by the school’s senior members of the staff, which in turn had an effect on the way it was perceived by the parents and students. In both schools, the teachers clearly reported during private conversations that the art lessons were conceived as a period for the students to ‘let off steam’. In the USA school, the teacher was a very highly motivated, knowledgeable and skillful teacher as well as an artist. His lessons were based on creativity and experimentation of ideas, materials and themes. From the Cypriot school, the teachers were very relaxed about their lessons which were mostly not planned. The student's work displayed on classroom walls within the Cypriot school's art department looked more like primary-school children's work.

**Area of concern 6: can coding skills of a certain image be acquired without the knowledge of decoding it?**

One view stated: ‘In all fields there is a relationship between coding and decoding which recognises the special quality of coding to a high level. So writing to a high level is generally given especially high value in the field of literacy. However, general education is by definition concerned with abilities that should be shared by everyone. Decoding is an essential ability for adults. You cannot participate in society without it. In general education coding is often practised because it is a good way of learning about decoding. Hence such statements as ‘the best way to learn about design is by designing’. Here is another area for further research’.

A different view stated: ‘It depends on the student. Some can both code and de-code very easily whereas others cope with one and struggle with the other. This may well link to learning style preferences’.
Figure 7: Most commonly used areas of graphicacy, in Cyprus, USA and UK

Most commonly used areas of graphicacy, in Cyprus, USA and UK
Round 4 letter for discussions

Dear (enter name),

I would like to thank all the participants so far for your time and valuable advice and comments on the matters raised for discussions. After this round of discussions (round 4), the main areas of this PhD would have been covered effectively having re-enforced aspects of the findings. Consequently, round 5 of discussions (sent out on the 8th of April) will be the last round for the Delphi group study. Round 5 will be focused on summarising the feedback received over the past few weeks and invite comments from anyone on these final positions. I would like to encourage you to feel free to approach me for private conversations through email at any time.

Three documents are attached with this email:
1. Feedback from Delphi group round 3 discussion
   An executive summary is provided summarising all areas of concern and actions taken towards these. A detailed discussion of the areas of concern follows, with some very interesting questions identified.
2. Delphi group discussion 4: Perspective descriptors
   The new area of discussion on drawing a descriptor list relating to drawing cuboids in perspective is introduced.
3. Questions sheet 4

All relevant questions to this round of discussions are presented. Please fill in ‘Question sheet 4’ and send it back by the Friday, 1 April 2011.

Xenia Danos

Delphi group discussion 4: Perspective drawing descriptors

This study was treated as a pilot study, testing out the methodology, design of tasks and analysis of results, with the final aim of generating continuity and progression descriptors when utilising the key competences. The various techniques used for different media were not included within the scope of this study.

For the perspective drawing task, the aim was to test the limits of the students’ abilities. Thus each task and exercise was building on the skills, knowledge and abilities learnt previously (Figure 1). The most challenging task students were asked to complete involved ‘cutting out’ pieces from cubes and rotating it in different directions. Figure 2 illustrates the stages of each lesson. Table 1 shows the initial generic criteria that were developed to assess the above work by the research team. The criteria were developed having reviewed common textbooks and teaching and learning resources in relation with the above tasks. This was a starting point to assess students’ work with the expectation that these would be developed further through the pilot study.
**Task d:** Draw freehand 3 different sized cubes

**Exercise:** Draw different sized cubes

**Task g:** ‘cut out’ and rotate cubes in 2 point perspective

**Task f:** Draw cubes in 2 point perspective

---

*Figure 1 Sequence of tasks and exercise on perspective*
Figure 2 Perspective: Stages of the lessons

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perspective</td>
<td>1. Accuracy in using the technique chosen i.e. use of parallel lines correctly</td>
</tr>
<tr>
<td></td>
<td>2. Size; The object became smaller as its distance from the observer increases</td>
</tr>
<tr>
<td></td>
<td>3. Depth; Proper use of perspective (if chosen) i.e. lines converging onto a point</td>
</tr>
</tbody>
</table>

Table 1 initial descriptors used to assess student’s work

**Perspective**

The group was taught two-point perspective for the first time so the first task was designed to identify the initial level of 3 dimensional drawing abilities. The descriptors were once again placed in an assumed order of difficulty. Figure 3 indicates the level of progression among the tasks. Drawing basic cube shapes freehand seems to have been one of the first and easiest tasks whereas the descriptors from the last and more challenging tasks clearly have the least number of successes.
Table 2 shows a sample of the analysis of one student’s work against the level descriptors for perspective drawing. The results from all students’ work is displayed in Figure 4.

<table>
<thead>
<tr>
<th>Two point perspective list descriptors</th>
<th>Students’ work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Student 1</td>
</tr>
<tr>
<td></td>
<td>1d</td>
</tr>
<tr>
<td><strong>3d cube</strong></td>
<td></td>
</tr>
<tr>
<td>Draw freehand a 3 dimensional cube</td>
<td>/</td>
</tr>
<tr>
<td>Correctly draw freehand 3 dimensional cube</td>
<td>/</td>
</tr>
<tr>
<td>Draw freehand a correct and accurate cube</td>
<td>/</td>
</tr>
<tr>
<td><strong>Basic technique</strong></td>
<td></td>
</tr>
<tr>
<td>Identify a horizon</td>
<td>n/a</td>
</tr>
<tr>
<td>Identify the vanishing point</td>
<td>n/a</td>
</tr>
<tr>
<td>Correct use of vertical lines drawn</td>
<td>n/a</td>
</tr>
<tr>
<td>Correct use of diagonal lines drawn to the vanishing point to form a cube</td>
<td>n/a</td>
</tr>
<tr>
<td>Drawing a cube correctly on, above and below eye level</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Modifying the main shape form</strong></td>
<td></td>
</tr>
<tr>
<td>Draw a cube in 2p.p. and remove a smaller cube from the left hand corner of the main shape</td>
<td>n/a</td>
</tr>
<tr>
<td>Draw a cube with a piece cut out in the front left hand corner.</td>
<td>n/a</td>
</tr>
<tr>
<td>Draw the above cube (with a piece cut out in the front left hand corner) using 2 p.p.</td>
<td>n/a</td>
</tr>
<tr>
<td>Rotate that image 90° to the right hand side and draw how it will look.</td>
<td>n/a</td>
</tr>
<tr>
<td>Draw the above cube in 2 p.p.</td>
<td>n/a</td>
</tr>
<tr>
<td>Draw how the last shape you have drawn will look like when rotated 90° downwards.</td>
<td>n/a</td>
</tr>
<tr>
<td>Draw the above cube in 2 p.p.</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Table 2 Two point perspective: students’ work analysis. Tasks ‘d’, ‘f’ and ‘g’ are illustrated in Figure 1

All but one student completed the first task (task d), with 30% of the students drawing 3 different sized cubes excellently. All but one student put effort in completing the exercise of drawing cubes using 2 point perspective which had a great success rate as 19 out of 24
students (79%) achieved excellence in this task according to the descriptors level. For the third task, despite the difficulty of it, where the students were guided to draw cubes with parts cut off, most students (22/24) were able to follow but were then struggling with individual aspects of the task, such as rotating the shape in different directions without adult help.

![Figure 4 Perspective: students’ rate of success per task](image)

Overall

Due to time restrictions, the students were not able to achieve their full potential on each task. Their current level of competency on each area of graphicacy was noted which showed some of their abilities but that was based on a limited amount of tasks and exercises completed by the students on one day. This has provided a good starting point to get to know the students’ basic level of understanding and knowledge but it did not provide a thorough description of what the students’ limitations and abilities were. The strategy has proven to be successful in allowing for a record to be kept on students’ learning and progression and forming a logical criteria list of competency levels.

Discussion

The rate of success each descriptor received indicates its level of difficulty. However, for a full set of results, this research will have to be conducted over a period of time while working with groups of pupils in order to record pupils’ full potentials and limitations across a range of year groups.

Documenting the stages of progression when learning and dealing with each type of image is fundamental in our understanding of the human development in graphicacy. Graphicacy is one of the four main communication skills and one which is often considered to be the most
complicated and less understood. This research once completed could form the basis for sound curriculum schemes of work based on the student's true abilities, potentials and natural development instead of assumed levels of competency.

Conclusion

- Tasks suitable for teaching, learning and assessing in areas related to graphicacy can be developed for purposes to generate level descriptors.

- The results from the task on perspective give an indication that there could be a hierarchical sequence within the descriptors.

Refined final descriptors for rendering; drawn after further reflection subsequent to analysis.

The descriptors presented below are placed in an assumed hierarchical order. No empirical evidence has been gathered suggesting the need to know how to draw freehand a 3-dimensional cube in order to be able to learn how to draw cubes using 2 point perspective. Common practise in teaching usually follows a progression from; creating 3D cubes; to one point perspective; two point perspective etc.

The workshop for the group of students who participated in this study was designed to cover a number of different levels of abilities. This was primarily due to their previously undefined level of competency. The assumption that the students have no prior knowledge of 3 dimensional drawing was incorporated. The descriptors following give an indication of the sequence of stages of understanding required to draw basic cuboids shapes in 3-D and using 2 point perspective.
**Freehand 3-dimensional cube**

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw freehand a 3 dimensional cube</td>
<td></td>
</tr>
</tbody>
</table>

Correctly draw freehand 3 dimensional cube (the correct number of visible sides to be drawn, according to the point of view)

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw freehand a correct and accurate cube (3 horizontal parallel lines, 3 vertical parallel lines and 3 diagonal parallel lines)</td>
<td></td>
</tr>
</tbody>
</table>

**Basic technique for 2 point perspective**

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify a horizon</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Successful example</th>
<th>Unsuccessful example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the vanishing point</td>
<td></td>
</tr>
</tbody>
</table>
Successful example

Draw a cube in 2 point perspective (2 p.p.) above/ below/ on the horizon
Use 1 vertical line to define the height (the centre line). Connect each end of the line to each vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. From the top point of the each of the last 2 drawn vertical lines, draw a line to the corresponding vanishing point.

Correctly draw a cube in 2 p.p.
Use 1 straight vertical line to define the height (the centre line). Using straight lines connect each end to the relative vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. All vertical lines should be parallel to one another. From the top point of the each of the 2 vertical lines drawn last, draw straight lines to the corresponding vanishing point.

Modifying the basic cube form

Create a drawing to indicating an understanding of how a cube would look like with a piece cut out along a corner.

Communicate correctly a cube with a piece cut out along a corner.
Accurately and correctly draw a cube with a piece cut out along the corner.
All vertical lines to be parallel to one another, all horizontal lines to be parallel to one another and all diagonal lines to be parallel to one another.

Draw the above cube in 2 p.p.

Correctly draw the above cube in 2 p.p.
Use 1 straight vertical line to define the height (the centre line). Using straight lines connect each end to the relative vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. All vertical lines should be parallel to one another. From the top point of the each of the 2 vertical lines drawn last, draw straight lines to the corresponding vanishing point.

Rotate that image 90° to the right hand side and draw how it will look using 2 p.p.
Questions sheet 4

Delphi group discussion 4: Perspective drawing descriptors

Name:

The area of focus of the PhD has been on identifying descriptors of outbound (coding information) skills related to graphicacy elements.

Questions 1: Is the methodology presented in the attachment ‘Delphi group discussion 4 Perspective drawing descriptors’ of gathering data within practice, appropriate?

Q1. Answer: Yes/ No
Q1. Comments:

Questions 2: Could this research strategy develop an understanding of progression in this area (perspective drawing) of graphicacy?

Q2. Answer: Yes/ No
Q2. Comments:

Questions 3: Given that these descriptors were developed through specific tasks, could they be used more widely for assessment for learning relating to the basic understanding of drawings cuboids freehand and using 2 point perspective?

Q3. Answer: Yes/ No
Q3. Comments:

Questions 4: Below is the final list of descriptors for perspective. Would you add, remove or change the order of any of them?

Q4. Answer: Yes/ No
Q4. Comments:

3-dimensional cube
  1. Draw freehand a 3 dimensional cube

Correctly draw the above cube in 2 p.p.

Use 1 straight vertical line to define the height (the centre line). Using straight lines connect each end to the relative vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. All vertical lines should be parallel to one another. From the top point of the each of the 2 vertical lines drawn last, draw straight lines to the corresponding vanishing point.
2. Correctly draw freehand 3 dimensional cube (the correct number of visible sides to be drawn, according to the point of view)
3. Draw freehand a correct and accurate cube (3 horizontal parallel lines, 3 vertical parallel lines and 3 diagonal parallel lines)

**Basic technique for 2 point perspective**

1. Identify a horizon
2. Identify the vanishing point(s)
3. Draw a cube in 2 point perspective (2 p.p.) above/ below/ on the horizon
   *Use 1 vertical line to define the height (the centre line). Connect each end of the line to each vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. From the top point of the each of the last 2 drawn vertical lines, draw a line to the corresponding vanishing point.*
   *Use 1 straight vertical line to define the height (the centre line). Using straight lines connect each end to the relative vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. All vertical lines should be parallel to one another. From the top point of the each of the 2 vertical lines drawn last, draw straight lines to the corresponding vanishing point.*

**Modifying the basic cube form**

1. Create a drawing to indicating an understanding of how a cube would look like with a piece cut out along a corner
2. Communicate correctly a cube with a piece cut out along a corner
3. Accurately and correctly draw a cube with a piece cut out along the corner
   *All vertical lines to be parallel to one another, all horizontal lines to be parallel to one another and all diagonal lines to be parallel to one another*
   *Use 1 straight vertical line to define the height (the centre line). Using straight lines connect each end to the relative vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. All vertical lines should be parallel to one another. From the top point of the each of the 2 vertical lines drawn last, draw straight lines to the corresponding vanishing point.*
6. Rotate that image 90° to the right hand side and draw how it will look using 2 p.p.
   *Use 1 straight vertical line to define the height (the centre line). Using straight lines connect each end to the relative vanishing point. Draw a vertical line on each side of the centre line to define the width of the cube. All vertical lines should be parallel to one another. From the top point of the each of the 2 vertical lines drawn last, draw straight lines to the corresponding vanishing point.*

**Questions 5:** Do you think the descriptors under the title ‘basic technique for 2 point perspective could also be applied when working with 1 point perspective?

**Q5. Answer:** Yes/ No

**Q5. Comments:**

In the light of round 3 discussion and feedback

**Questions 6:** In the light of this feedback, do you think the task was appropriate?

**Q6. Answer:** Yes/ No

**Q6. Comments:**

**Questions 7:** Would you suggest using more fluid forms as a starting point for introducing the concept of rendering?

**Q7. Answer:** Yes/ No
Q7. Comments:

Questions 8: Do you have a specific age range in mind for the above suggestion?
Q8. Answer: Yes/ No
Q8. Comments:

Questions 9: Do you think it would be appropriate for year 7 students (ages 11-12)?
Q9. Answer: Yes/ No
Q9. Comments:

Questions 10: Can young students go straight into understanding the philosophy of rendering by working on more fluid forms?
Q10. Answer: Yes/ No
Q10. Comments:

Questions 11: Do you think adding shadow correctly according to the distance of the light source is more or less difficult than adding shadow to suggest the correct form of the shape (Figure 1)
Q11. Answer: less / more difficult
Q11. Comments:

Figure 1 Items 12 and 13 from the rendering descriptors list

Additional/ general comments:

Feedback from Delphi group round 3 discussion
Executive summary

All responses and feedback from discussion 3 have been gathered, analysed and appropriate responses have been drawn. The main matters (areas of concern) to be addressed are listed in an executive summary below (Table 1) and are described in further detail subsequently. Opportunities to comment on the results of round 3 and the next matter raised for this group; ‘perspective drawing descriptors’ is provided in the attachment ‘Question Sheet 4’.

General comments

All participants agreed on the appropriateness of the methodology presented for gathering data within practice. The approach has been described to be ‘extremely appropriate knowing the scarcity of similar efforts as well as the difficulty for identifying the relevant descriptors in a way that could indicate continuity and progression’. More specifically, it was agreed that this way an understanding of progression in rendering can be developed. Two contradictory opinions were raised relating to the appropriateness of the tasks developed. One supported that ‘the presented examples clearly exemplify that the specific strategy has the potential to develop a totally clear understanding of progression in rendering concerning graphicity’. However, a recommendation was made to use more fluid forms of rendering for real purposes instead of the simple shapes used in the task. In order to offer more useful data, it could be used as part of a coursework assignment. This is an interesting idea which is pursued further in our next discussion. Contradictory views were also gathered relating to the usefulness of the descriptors generated. One view states that ‘The generated descriptors seem extremely useful for the assessment of learning relating to rendering. The same descriptors can guide as well teaching interventions for further in-depth studying of rendering’. Another view puts emphasis on how these descriptors could be used to assess different renderings done by different students in different media. The list of descriptors provided has been described as ‘very interesting’ and one participant stated that ‘it works for the task being studied. It is important to clarify that the list is not exhaustive and merely provides an example of a method to collect such descriptors and initial set of results. Further work has to be completed if it is to include aspects such as different media, shapes, multiple or coloured light sources etc. The order of 2 items on the descriptors list has been challenged according to the level of difficulty. The use of illustrations to support assessment decision in a visual subject has been described as ‘effective and should be explored further perhaps in relation to more authentic tasks’.

Table 1 Areas of concerns & responses

<table>
<thead>
<tr>
<th>Areas of concern</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is the methodology presented for gathering data within practice appropriate?</td>
<td>100% - Yes</td>
</tr>
<tr>
<td>2. Could this research strategy develop an understanding of progression in rendering?</td>
<td>100% - Yes</td>
</tr>
<tr>
<td>3. Do you think the descriptors generated would be useful during assessment for learning relating to rendering?</td>
<td>67% - Yes, 33% - No</td>
</tr>
<tr>
<td>4. Why not use more fluid forms of rendering for the test</td>
<td>Explained in the detail discussions area. Additionally, it has been added in the discussion of round 4 for further discussion.</td>
</tr>
<tr>
<td>5. Do you think the descriptors generated would be useful during assessment for learning relating to rendering?</td>
<td>67% - Yes, 33% - No, because it isn’t assessment for learning</td>
</tr>
<tr>
<td>6. Would you add, remove or change the order of any of final list of descriptors?</td>
<td>33% - Yes, 67% - No</td>
</tr>
<tr>
<td>7. ‘Shadow added to suggest the correct form of the shape’ seems to be more difficult that ‘shadow added correctly according to the distance of the light source’</td>
<td>Explained in the detail discussions area. Additionally, it has been added in the discussion of round 4 for further discussion.</td>
</tr>
</tbody>
</table>
Detailed discussions of the areas of concern that arose

General comments

- The method would be difficult to apply to more expressive forms of drawing. For example, the heavy swirling lines that might be used to express stormy water could also be used to express a mood of turmoil of the psychology of despair. There is here a ‘language’ of marks that are part of graphicacy. I’d say they can be described for any particular cultural context but not with the same precision as rendering because the desired result is not necessarily known in advance. The message emerges from the use of the medium and its potential expressive power. If it is objected that the more expressive repertoire cannot be taught or assessed, I’d disagree. It has been taught successfully in artists’ ateliers and art schools and more recently in primary and secondary schools as well.  
- The method and the type of descriptors used are ideal for dealing with graphic elements where there is an agreed ‘correct’ outcome and an accepted methodology for achieving it. This is the case in many specialist uses of drawing. For example, map making, anatomical illustration etc. Also for certain conventions of depiction - 3 point perspective, shading, representational portraiture, for example.

Area of concern 1: further refinement of the methodology to reflect normal learning pattern

‘The methodology presented was very interesting but could be further refined. Instead of relying on teachers views of student’s current level of attainment it would have been appropriate to collect a sample of drawing/design work from each students’ normal lessons to act as baseline data. I do understand that the first drawing without intervention could be said to fulfil this function but it wasn’t part of their normal learning pattern and may not be reflective of it’.

The focus of this research was to identify as accurately as possible the students’ understanding of certain elements of graphicacy, instead of identifying what the students do in their normal teaching environments. The task set for the children has to be right for this study, i.e. focused on graphicacy skills instead of a subject based task where the application of graphicacy amongst other skills is required. In this example I was looking at the stages of understanding when dealing with rendering. These basic skills can later be applied by numerous subject areas for various tasks.

Area of concern 2: Use a study which is focused in a similar way as the one described in round 3 of discussions, but on more fluid forms of rendering for real purpose. Perhaps as part of a coursework assignment would offer more useful data.

Basic shapes were used as a starting point in order for the students to get a basic understanding of how light hits simple shapes and the effect that may have on them before merging more shapes together to form a more complex form. The aim of this study was to identify the level of understanding students have on how the light hits different shaped objects and the effect that has on them. Through my own teaching experience, I thought it was appropriate to test the students initially using the basic theory of rendering. You can answer the following questions in ‘Question sheet 4’:

- In the light of this feedback, do you think the task was appropriate?
- Would you suggest using more fluid forms as a starting point for introducing the concept of rendering?
- Do you have a specific age range in mind for the above suggestion?
- Do you think more fluid forms would be appropriate for year 7 students (ages 11-12)?
- Can young students go straight into understanding the philosophy of rendering by working on more fluid forms?
Area of concern 3: How might one assess different renderings done by different students in different media?
The descriptors provided form the very basic information to be taught about rendering. The case study has been successful as a starting point to illustrate that the methodology works and results can be obtained on this area. For a more elaborate and inclusive descriptors list, a lot more in-depth research has to be completed, to include different media, fluid shapes etc.

Area of concern 4: Item 12; Shadow added to suggest the correct form of the shape) seems to be more difficult that item 13; shadow added correctly according to the distance of the light source (Figure 1)
This author’s opinion assumed that item 12 needs no technical knowledge, only the understanding that a shape will have a similar but elongated shadow, whereas item 13 needs a broader understanding of the edges and corners the light hits on and how that joins with the lines of the ground. This is an area that will be discussed further in discussion round 4. Cutting off the shadow at the right length requires an understanding of the position of the light source.

![Figure 1 Items 12 and 13 from the rendering descriptors list](image)
**Feedback from Delphi group rounds 1 - 4**

In general there has been a very positive reaction towards the discussions brought forward in this study. The research has been described as very interesting and ‘extremely good work that could proved to be helpful from many respects’. The methodologies described for various research has been approved and deemed as appropriate for each relevant study. The Delphi group study brought up and identified some very good issues relating to this research. A number of agendas have been defined relating to continuity and progression descriptors. These will be targeted to be addressed during the discussion part of the thesis. A number of references were also provided during this study, which will aid in updating the existing literature review.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Actions / responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think the Delphi group method described is appropriate/ doable?</td>
<td>All participants agreed on the appropriateness of the Delphi study group.</td>
</tr>
<tr>
<td>Are the categories within the taxonomy for graphicy the ones you would expect? Please indicate if you consider each category appropriate or not (Taxonomy was illustrated in a Figure)</td>
<td>Discussions resulted on making some changes such as:</td>
</tr>
<tr>
<td></td>
<td>- remove CARTOONS from the sequential category</td>
</tr>
<tr>
<td></td>
<td>- More photographs into a separate category</td>
</tr>
<tr>
<td></td>
<td>- Change the title of the ART category to WESTERN ART</td>
</tr>
<tr>
<td>Are there any elements which you feel have been missed out?</td>
<td>Some strong opinions were shared on the importance of GRAPHIC ARTS as part of the taxonomy</td>
</tr>
</tbody>
</table>

**Round 2: Cross-curricular links**
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think 'version 2 of the taxonomy is a comprehensive and appropriate research tool for research in an educational context with regards to the types of images and the graphicacy skills (the ability to communicate [code &amp; decode] information through still visual images) required to deal with them'?</td>
<td>All participants agreed on the statement provided. The importance of viewing the taxonomy as a work-in-progress was emphasised.</td>
</tr>
<tr>
<td>Do you think breaking up the taxonomy into 25 types of images was the appropriate method for a research tool to be used in the study described above?</td>
<td>All participants were in agreements with the appropriateness of the taxonomy use during the cross-curricular textbooks' analysis.</td>
</tr>
<tr>
<td>Is there anything within the results illustrated in Figure 2 which is unexpected?</td>
<td>Most participants expected a lot more variety of graphicacy elements to be studied during art classes.</td>
</tr>
<tr>
<td>Do you think the cross-curricular links indentified are equally appropriate for inbound and outbound graphicacy skills (coding and decoding information)?</td>
<td>More than half of the participants (60%) believed the cross-curricular results could be different if broken down into inbound or outbound graphicacy skills</td>
</tr>
<tr>
<td>Is there a difference between the level of difficulty in dealing with coding and decoding the same type of image?</td>
<td>All participants believed that there is going to be a difference in difficulty.</td>
</tr>
<tr>
<td>Do you think one can acquire outbound graphicacy skills (coding/ creating an image) without having obtained the required inbound graphicacy skills (decode, read and understand information) relating to the same type of image?</td>
<td>Most participants (80%) believed it wouldn't be possible to acquire outbound skills without having obtained the required inbound skills relating to the same type of image.</td>
</tr>
<tr>
<td><strong>Round 3 rendering descriptors</strong></td>
<td></td>
</tr>
<tr>
<td>Is the methodology presented in the attachment ‘Delphi group discussion 3 Rendering descriptors’ for gathering data within practice, appropriate?</td>
<td>All participants agreed on the appropriateness of the methodology.</td>
</tr>
<tr>
<td>Could this research strategy develop an understanding of progression in this element (rendering) of graphicacy?</td>
<td>All participants believed that to be possible.</td>
</tr>
<tr>
<td>Do you think the descriptors generated would be useful during assessment for learning relating to rendering?</td>
<td>The majority of the participants (67%) believed that would be useful.</td>
</tr>
<tr>
<td>(The final list of descriptors for rendering was provided in a list) Would you add, remove or change the order of any of them?</td>
<td>Most participants (67%) believed that list was fine as it was.</td>
</tr>
<tr>
<td><strong>Round 4 perspective drawing descriptors</strong></td>
<td></td>
</tr>
<tr>
<td>Is the methodology presented in the attachment ‘Delphi group discussion 4 Perspective drawing descriptors’ of gathering data within practice, appropriate?</td>
<td>All participants agreed on the appropriateness of the methodology.</td>
</tr>
<tr>
<td>Could this research strategy develop an understanding of progression in this area (perspective drawing) of graphicacy?</td>
<td>All participants believed that to be possible.</td>
</tr>
<tr>
<td>Given that these descriptors were developed through specific tasks, could they be used more</td>
<td>Half the participants believed that would be possible. No explanation was provided.</td>
</tr>
<tr>
<td>Question</td>
<td>Response</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>widely for assessment for learning relating to the basic understanding of drawings cuboids freehand and using 2 point perspective?</td>
<td>by the participants who believed that would not be possible.</td>
</tr>
<tr>
<td>(The final list of descriptors for perspective drawing was provided in a list) Would you add, remove or change the order of any of them?</td>
<td>Most participants (75%) believed the list was fine. A small number, believed some stages should be broken into several smaller steps.</td>
</tr>
<tr>
<td>Do you think the descriptors under the title ‘basic technique for 2 point perspective could also be applied when working with 1 point perspective?</td>
<td>Most participants (75%) believed that the list could be applied also when working with 1 point perspective.</td>
</tr>
<tr>
<td>Would you suggest using more fluid forms as a starting point for introducing the concept of rendering?</td>
<td>All participants agreed this would not make an ideal starting point but it is something that should be introduced eventually.</td>
</tr>
<tr>
<td>Do you think it would be appropriate for year 7 students (ages 11-12)?</td>
<td>The opinion on this question was divided as 50% believed it would, and the other 50% believed it would not.</td>
</tr>
<tr>
<td>Can young students go straight into understanding the philosophy of rendering by working on more fluid forms?</td>
<td>Most participants believed that would not be possible. However, 25% believed it would be.</td>
</tr>
</tbody>
</table>
Appendix 5.1 Looking for patterns – Analysing the purpose each image was used for

Teaching and learning purpose of each image

Category: Pictorial - art
<table>
<thead>
<tr>
<th>Category: Pictorial – Art</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USA</strong></td>
</tr>
<tr>
<td>Languages: read a poem and draw interpretation, to show understanding and creativity</td>
</tr>
<tr>
<td>Calculus: art created using numbers</td>
</tr>
<tr>
<td>Art: copy original painting in colour acrylic, learning colours and composition</td>
</tr>
<tr>
<td>History: paintings illustrating ideas and events of the past, to place new knowledge into context</td>
</tr>
<tr>
<td><strong>CYPRUS</strong></td>
</tr>
<tr>
<td>RE: illustrations of RE historical times, to place new knowledge into context</td>
</tr>
<tr>
<td>Art: learning how to create and use patterns</td>
</tr>
<tr>
<td>Music: well known paintings, to spark conversation about history of music</td>
</tr>
<tr>
<td>Physics: cover sheet to suggest physics, decorative</td>
</tr>
<tr>
<td>Greek: paintings illustrating ideas and events of the past, to place new knowledge into context</td>
</tr>
<tr>
<td>History: paintings illustrating ideas and events of the past, to place new knowledge into context</td>
</tr>
<tr>
<td>DT: poster drawing, illustrate students’ knowledge and understanding while learning how to draw images for a poster</td>
</tr>
</tbody>
</table>
Category: Pictorial – drawing

Pictorial—drawings  USA

Calculus

ICT Java  Biology  Chemistry

Languages
Appendices

Pictorial—drawings

Cyprus

Music

Physics

ICT

History
Pictorial—drawings

Cyprus

DT

Languages
<table>
<thead>
<tr>
<th>Category: Pictorial – drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USA</strong></td>
</tr>
<tr>
<td>Calculus 1: image used for visual stimulation, Necessary?</td>
</tr>
<tr>
<td>Calculus 2: image used for visual stimulation, unnecessarily/ place knowledge into context</td>
</tr>
<tr>
<td>ICT Java: illustrating an idea/ action to help embedded new knowledge</td>
</tr>
<tr>
<td>Biology: illustrate a dissected cell to support embed new knowledge</td>
</tr>
<tr>
<td>Chemistry 1: illustrating a chain of amino-acids to support embed new knowledge</td>
</tr>
<tr>
<td>Chemistry 2: image used to place new knowledge into context</td>
</tr>
<tr>
<td>Languages 1: illustrate activities to spark a conversation</td>
</tr>
<tr>
<td>History: Comparative illustrations to support embed new knowledge</td>
</tr>
<tr>
<td><strong>CYPRUS</strong></td>
</tr>
<tr>
<td>Biology: list of new equipment to place new knowledge into context</td>
</tr>
<tr>
<td>Chemistry 1: illustration of a test to support embed new knowledge</td>
</tr>
<tr>
<td>Chemistry 2: image used to place new knowledge into context</td>
</tr>
<tr>
<td>Mathematics 1: image used to place new knowledge into context</td>
</tr>
<tr>
<td>Mathematics 2: image used to place new knowledge into context</td>
</tr>
<tr>
<td>Mathematics 3: explanatory illustrations to support embed new knowledge</td>
</tr>
<tr>
<td>Music 1: image used to place new knowledge into context</td>
</tr>
<tr>
<td>Music 2: explanatory illustrations to support embed new knowledge</td>
</tr>
<tr>
<td>Physics 1+4: explanatory illustrations to support embed new knowledge</td>
</tr>
<tr>
<td>History: visual aid to solve exercises, image used to place new knowledge into context</td>
</tr>
<tr>
<td>ICT: explanatory illustrations to support embed new knowledge</td>
</tr>
<tr>
<td>DT 1: illustrate students’ ideas, knowledge and understanding</td>
</tr>
<tr>
<td>DT 2: visual aid used to place new knowledge into context</td>
</tr>
<tr>
<td>DT 3: explanatory illustrations to support embed new knowledge</td>
</tr>
<tr>
<td>Languages 1: to spark interest and illustrated students’ ideas, knowledge and understanding</td>
</tr>
<tr>
<td>Languages 2: illustrate activities to spark a conversation</td>
</tr>
</tbody>
</table>
Category: Sequential – story boards

**Sequential—story boards**

**Geometry**

![Geometry Diagram]

**Biology**

![Biology Diagrams]

**USA**

**ICT Java**

![ICT Java Diagram]

Figure 6.1 Creating Objects from a Class
Sequential—story boards

Languages

USA

History

Cyprus

Mathematic
Sequential—story boards

Music

RE

DT

Languages
Sequential—story boards

ICT

Cyprus

Biology

Chemistry
## Category: Sequential – story boards

<table>
<thead>
<tr>
<th>Country</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USA</strong></td>
<td><strong>Geometry:</strong> illustrate a mathematical sequence to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>ICT Java:</strong> illustrating an idea/ action to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>Biology:</strong> illustrating an action/ development to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>Languages:</strong> illustrate a series of activities to spark a conversation</td>
</tr>
<tr>
<td></td>
<td><strong>History:</strong> illustrating an idea/ action to help embedded new knowledge</td>
</tr>
<tr>
<td><strong>CYPRUS</strong></td>
<td><strong>Mathematics:</strong> illustrate a mathematical sequence to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>Music:</strong> to place new knowledge into context</td>
</tr>
<tr>
<td></td>
<td><strong>RE:</strong> illustrating an action/ development to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>DT:</strong> illustrate how-to process to place new knowledge into context</td>
</tr>
<tr>
<td></td>
<td><strong>Languages 1:</strong> illustrate a series of activities to spark a conversation</td>
</tr>
<tr>
<td></td>
<td><strong>Languages 2:</strong> illustrate how-to process to spark a conversation</td>
</tr>
<tr>
<td></td>
<td><strong>Geography:</strong> illustrating an action/ development to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>Greek:</strong> illustrate how-to process to spark a conversation</td>
</tr>
<tr>
<td></td>
<td><strong>History:</strong> illustrating an action/ development to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>ICT 1:</strong> instructions how-to to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>ICT 2:</strong> illustrating an action/ development to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>ICT 3:</strong> to place new knowledge into context</td>
</tr>
<tr>
<td></td>
<td><strong>Biology 1:</strong> to place new knowledge into context</td>
</tr>
<tr>
<td></td>
<td><strong>Biology 2:</strong> illustrating an action/ development to help embedded new knowledge</td>
</tr>
<tr>
<td></td>
<td><strong>Chemistry:</strong> to place new knowledge into context</td>
</tr>
</tbody>
</table>
Category: Symbolic – photographs

**Symbolic — photographs**

Calculus

[Images of calculus problems and concepts]

Geometry

[Images of geometric problems and concepts]

USA
Symbolic — photographs

ICT Java

USA

Biology

Chemistry

History

Art

Historical Plan for Versailles – chateau and grounds.
Symbolic — photographs

Cyprus

Languages

Geography

Greek

History

ICT

Chemistry
### Category: Symbolic – photographs

#### USA
- **Calculus 1:** image used for visual stimulation, Necessary?  
  gain familiarity, to place new knowledge into context  
- **Geometry 1:** gain familiarity, to place new knowledge into context  
- **Geometry 2:** gain familiarity, to place new knowledge into context  
- **Geometry 3:** image used for visual stimulation, Necessary?  
- **ICT Java:** gain familiarity, to place new knowledge into context  
- **Biology:** gain familiarity, to place new knowledge into context  
- **Chemistry:** gain familiarity, to place new knowledge into context  
- **History:** provoke interest – connect knowledge to reality  
- **Art:** to provoke interest

#### CYPRUS
- **Mathematics:** gain familiarity, to place new knowledge into context  
- **Music:** provoke interest, spark a conversation  
- **Physics:** gain familiarity, to place new knowledge into context  
- **RE:** gain familiarity, to place new knowledge into context  
- **DT 1:** gain familiarity, to place new knowledge into context  
- **DT 1:** provoke interest, spark a conversation  
- **Biology:** gain familiarity, to place new knowledge into context  
- **Languages:** provoke interest, spark a conversation  
- **Geography 1:** provoke interest, spark a conversation  
- **Geography 2:** gain familiarity, to place new knowledge into context  
- **Greek:** to support embed new knowledge  
- **Chemistry:** gain familiarity, to place new knowledge into context  
- **ICT:** gain familiarity, to place new knowledge into context
Category: CAD - CAD

**CAD — CAD**

- Calculus
- Geometry
- Biology

**Chemistry**

**Physics**

**Cyprus**

**DT**

**ICT**

**Greek**

**Physics**
### Category: CAD – CAD

#### USA

- **Calculus**: annotated cross section diagram, explanatory illustrations to support embed new knowledge
- **Geometry**: annotated, perspective drawing, explanatory illustrations to support embed new knowledge
- **Biology**: symbolic – iconic representation of a complex theory, explanatory illustrations to support embed new knowledge
- **Chemistry**: explanatory illustrations to support embed new knowledge

#### CYPRUS

- **Physics**: technical drawing, gain familiarity, to place new knowledge into context
- **DT**: how to- instructions, gain familiarity, to place new knowledge into context
- **ICT**: photograph, gain familiarity, to place new knowledge into context
- **Greek**: aesthetically used
- **Physics**: Symbolic, iconic representation to gain familiarity, to place new knowledge into context
- **Biology 1**: annotated cross section diagram illustrate students’ ideas, knowledge and understanding
- **Biology 2**: Symbolic, bar chart explanatory illustrations to support embed new knowledge
- **Chemistry**: symbolic representation using perspective, explanatory illustrations to support embed new knowledge
Category: Other

**Other**

<table>
<thead>
<tr>
<th>USA</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICT Java</td>
<td>Chemistry</td>
</tr>
<tr>
<td>Figure 11: The Roman program</td>
<td></td>
</tr>
</tbody>
</table>

**Cyprus**

<table>
<thead>
<tr>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT</td>
</tr>
<tr>
<td>ТРУНОМА</td>
</tr>
<tr>
<td>Μελαικό παρασκευαστήριο για να μην ρυθμίζετε την συνδεδεμένη κατασκευή.</td>
</tr>
<tr>
<td>Les nombres</td>
</tr>
<tr>
<td>Mote et expressions</td>
</tr>
<tr>
<td>a. Relie les phrases.</td>
</tr>
<tr>
<td>Il est</td>
</tr>
<tr>
<td>des jeans</td>
</tr>
<tr>
<td>petit</td>
</tr>
<tr>
<td>brun</td>
</tr>
<tr>
<td>un tee-shirt</td>
</tr>
</tbody>
</table>
### Category: Other

#### USA
- ICT Java: table, to organize information
- Chemistry: table, organize information
- Languages: crossword, learn through play

#### Cyprus
- DT 1: crossword, learn through play
- DT 2: table, to organize information
- Languages 1: crossword, learn through play
- Languages 2: crossword, learn through play
- Languages 3: learn through play and drawing
- Languages 4: board game, learn through play
- Languages 5: connect the right words, learn through play
- Greek 1: crossword, learn through play
- Greek 2: connect the right words, learn through play
- History: crossword, learn through play
- Chemistry: crossword, learn through play
- Biology: crossword, learn through play
Appendix 5.2 Areas of concern raised by the Delphi study group relating to the study focused on rendering

Area of concern 1: further refinement of the methodology to reflect normal learning pattern

‘The methodology presented was very interesting but could be further refined. Instead of relying on teachers views of student’s current level of attainment it would have been appropriate to collect a sample of drawing/design work from each students’ normal lessons to act as baseline data. I do understand that the first drawing without intervention could be said to fulfil this function but it wasn’t part of their normal learning pattern and may not be reflective of it’. The focus of this research was to identify as accurately as possible the students’ understanding of certain elements of graphicacy, instead of identifying what the students do in their normal teaching environments. The task set for the children has to be right for this study, i.e. focused on graphicacy skills instead of a subject based task where the application of graphicacy amongst other skills is required. In this example I was looking at the stages of understanding when dealing with rendering. These basic skills can later be applied by numerous subject areas for various tasks.

Area of concern 2: How might one assess different renderings done by different students in different media?

The descriptors provided form the very basic information to be taught about rendering. The case study has been successful as a starting point to illustrate that the methodology works and results can be obtained on this area,. For a more elaborate and inclusive descriptors list, a lot more in-depth research has to be completed, to include different media, fluid shapes etc.

Area of concern 3: Item 12; Shadow added to suggest the correct form of the shape) seems to be more difficult that item 13; shadow added correctly according to the distance of the light source (Figure 1)

This author’s opinion assumed that item 12 needs no technical knowledge, only the understanding that a shape will have a similar but elongated shadow, whereas item 13 needs a broader understanding of the edges and corners the light hits on and how that joins with the lines of the ground. This is an area that will be discussed further in discussion round 4. Cutting off the shadow at the right length requires an understanding of the position of the light source.
Figure 1 Items 12 and 13 from the rendering descriptors list

Item 12: Shadow added to suggest the correct form of the shape.

Item 13: Shadow added correctly according to the distance of the light source, suggesting the correct form of the shape.

Drawing 2 lines passing through each corner of the box. One extends from the light source, the other is either parallel lines or from a vanishing point if using perspective. Where lines from the same vertical plane (of the object) intersect, is the point the shadow will reach.
## Appendix 5.3 Portrait drawing result analysis

<table>
<thead>
<tr>
<th>Mark location of facial features</th>
<th>Student 1</th>
<th>Student 2</th>
<th>Student 3</th>
<th>Student 4</th>
<th>Student 5</th>
<th>Student 6</th>
<th>Student 7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>1. Draw outline for the top</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>half of the skull (diameter)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>by defining the centre and</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>drawing a circle i.e. 0.25 cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Circle to have a constant</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>radius (perfect circle)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Draw a horizontal line to</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>clearly define the middle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of the circle</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>4. Draw a horizontal straight</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>line (0°)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Draw a vertical line to</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>clearly illustrate the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inside of the circle</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>6. Draw a vertical straight</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>line (0°)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Draw vertical lines 12 cm</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>on each side of the circle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Draw straight vertical lines</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>90° (as described above)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Divide the space between</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>the two ears in 5 equal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>spaces i.e. 5 cm each</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>10. Divide the circle into 6</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>equal in height sections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.e. 7.5 cm in height</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>11. Add 2 more lines under the</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>circle using the same</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>distance/height i.e. 5.5</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Mark the following: air</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>line, eye brows, eyes,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ears, nose, lips and chin</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>13. Mark the width of the</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>nose by drawing a triangle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>from the centre of the</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>circle through to the 3rd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&amp; 4th vertical mark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Construction lines drawn</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>lightly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

480
<table>
<thead>
<tr>
<th></th>
<th>Student 1</th>
<th>Student 2</th>
<th>Student 3</th>
<th>Student 4</th>
<th>Student 5</th>
<th>Student 6</th>
<th>Student 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand size/ratio of facial features</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The length of an eye should fit 5 times along the length of the head</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>The ear starting inner with the eyes and ends at the tip of the nose</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Draw the correct width of the nose based on the construction line</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Draw the correct length of the mouth based on the construction line</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Drawing the facial features</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- draw eyes</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>- draw almond shaped eyes</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>- The height of each eye to be about half its width</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>- left eye being reflection of the right eye across the central vertical line</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Nose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Draw/draw a nose</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>- indicate the tip of the nose</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>- draw an arc to indicate the tip of the nose</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>- draw an arc, starting from one diagonal line reaching the second diagonal line to indicate the tip of the nose</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>- symmetry between left and right side</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>- draw nostrils</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>- draw the outline for the nostrils starting and ending on the diagonal line</td>
<td>N</td>
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<tr>
<td>- symmetry between left and right side</td>
<td>N</td>
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<td>Student 6</td>
<td>Student 7</td>
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<tr>
<td><strong>Mouth</strong></td>
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</tr>
<tr>
<td>- draw the mouth</td>
<td>Y Y Y - -</td>
<td>Y Y Y - -</td>
<td>Y Y Y - -</td>
<td>Y Y Y - -</td>
<td>Y Y Y - -</td>
<td>Y Y Y - -</td>
<td>Y Y Y - -</td>
</tr>
<tr>
<td>- draw a Drake line for separating the top from the bottom lip</td>
<td>N Y N / A</td>
<td>Y N N / A</td>
<td>Y N N / A</td>
<td>Y N N / A</td>
<td>Y N N / A</td>
<td>Y N N / A</td>
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</tr>
<tr>
<td>- draw the top lip</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
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<tr>
<td>- draw the top lip indicating the correct shape</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
</tr>
<tr>
<td>- draw the bottom lip</td>
<td>Y Y N / A</td>
<td>Y Y N / A</td>
<td>Y Y N / A</td>
<td>Y Y N / A</td>
<td>Y Y N / A</td>
<td>Y Y N / A</td>
<td>Y Y N / A</td>
</tr>
<tr>
<td>- draw the bottom lip indicating the correct shape</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
</tr>
<tr>
<td>- add medium darkness lines to indicate the shape of the nose</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
</tr>
<tr>
<td>- symmetry between left and right side</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
<td>N Y N / A</td>
</tr>
</tbody>
</table>

| **Eyebrows**    |           |           |           |           |           |           |           |
| - add eyebrows | N Y Y - - | N Y Y - - | N Y Y - - | N Y Y - - | N Y Y - - | N Y Y - - | N Y Y - - |
| - add eyebrows by starting below the construction line, redrawing above the line and ands at the same level it started | N Y Y - - | N Y Y - - | N Y Y - - | N Y Y - - | N Y Y - - | N Y Y - - | N Y Y - - |
| - add medium darkness lines to indicate the outline of the eyebrow | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A |
| - symmetry between left and right side | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A |

| **Ears**        |           |           |           |           |           |           |           |
| - draw the ear  | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - |
| - top half of the ear to be crude as long as the bottom half | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - |
| - start and end drawing the ear on the same straight vertical line | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - |
| - indicate the thickness of the tub | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A | N Y N / A |
| - left ear to be a reflection of the right ear | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - | N Y N - - |

Appendices
### Eyebrows
- dark eyebrows  
  - the circle to be partly "hidden" by the top eyebrow  
  - round in shape  
  - leave a small white spot  
  - the distance between the crease and i.e. left side of each eye to be the same  
  - symmetry between left and right side

### Hairline
- draw a baseline  
- starting from the (bottom) point of the ear connect on the construction line  
- the line going upwards in a straight line to define the forehead  
- follow realistic shape according to the form of the forehead  
- symmetry between left and right side  
- starting from a high point of the hole (ear), draw the outline for the hair outside the circular construction line

### Jaw
- draw a jaw  
- start from the point were the bottom of the ear connects to the construction line  
- draw a distinct corner angle below the outline line  
- draw the end of the chin with a horizontal line at least as long as the mouth  
- symmetry between left and right side

<table>
<thead>
<tr>
<th></th>
<th>Student 1</th>
<th>Student 2</th>
<th>Student 3</th>
<th>Student 4</th>
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<td>C</td>
<td>D</td>
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483
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<th>Mark location of facial features</th>
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<th>Student 9</th>
<th>Student 10</th>
<th>Student 11</th>
<th>Student 12</th>
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<tbody>
<tr>
<td>1. Draw outline for the top</td>
<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
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<tr>
<td>half of the skull (diameter)</td>
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<td>by defining the centre and</td>
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<tr>
<td>drawing a circle i.e. 0.30 cm</td>
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<tr>
<td>2. Circle to have a constant</td>
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<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
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<tr>
<td>radius (perfect circle)</td>
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<tr>
<td>3. Draw a horizontal line</td>
<td>N N N N N</td>
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<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
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<tr>
<td>to clearly define the middle</td>
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<tr>
<td>of the circle</td>
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<tr>
<td>4. Draw a horizontal straight</td>
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<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
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<tr>
<td>line (O')</td>
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<tr>
<td>5. Draw a vertical line to</td>
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<td>clearly illustrate the middle</td>
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<tr>
<td>6. Draw a vertical straight</td>
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<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
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<tr>
<td>line (30°)</td>
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<td>7. Draw vertical lines 1/12</td>
<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
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<tr>
<td>of the diameter, inside each</td>
<td></td>
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<td>circle to define the distance</td>
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<td>A A A A A</td>
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<tr>
<td>between the ears</td>
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<tr>
<td>8. Draw straight vertical</td>
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<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
<td>N N N N N</td>
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<tr>
<td>lines 90° (as described above)</td>
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<td>A A A A A</td>
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<tr>
<td>9. Divide the space between</td>
<td>N Y N</td>
<td>N Y N</td>
<td>N Y N</td>
<td>N Y N</td>
<td>N Y N</td>
</tr>
<tr>
<td>the two ears in 5 equal spaces</td>
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<tr>
<td>each i.e. 5 cm each</td>
<td>Y Y N</td>
<td>Y Y N</td>
<td>Y Y N</td>
<td>Y Y N</td>
<td>Y Y N</td>
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<tr>
<td></td>
<td>N Y N</td>
<td>N Y N</td>
<td>N Y N</td>
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<tr>
<td>10. Divide the circle into 8</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
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<tr>
<td>equal in height sections</td>
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<tr>
<td>i.e. 7.5 cm in height</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
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<tr>
<td></td>
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<td>N Y Y</td>
<td>N Y Y</td>
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<tr>
<td>11. Add 2 more lines under the</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
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<tr>
<td>circle using the same distance</td>
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<td>i.e. 5.7 cm</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
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<tr>
<td>12. Mark the following line,</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
</tr>
<tr>
<td>eye brows, eyes, ears, nose,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lips, chin</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
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<tr>
<td>13. Mark the width of the nose</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
<td>N Y Y</td>
</tr>
<tr>
<td>by drawing a triangle from the</td>
<td></td>
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<tr>
<td>centre of the circle through</td>
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<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
<td>Y Y Y</td>
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<tr>
<td>the 3rd &amp; 4th vertical mark</td>
<td>N Y N</td>
<td>N Y N</td>
<td>N Y N</td>
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<td>14. Construction lines drawn</td>
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<td>N N N</td>
<td>N N N</td>
<td>N N N</td>
<td>N N N</td>
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<tr>
<td>lightly</td>
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<td></td>
<td>A A A A A</td>
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<tr>
<td><strong>Understand size/ratio of facial features</strong></td>
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<tr>
<td>The length of an eye should fit 5 times along the length of the head</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>The ear starting inline with the eyes and ends at the tip of the nose</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>/ A</td>
</tr>
<tr>
<td>Draw the correct width of the nose based on the construction line</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>/ A</td>
</tr>
<tr>
<td>Draw the correct length of the mouth based on the construction line</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>/ A</td>
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<td><strong>Drawing the facial features</strong></td>
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<tr>
<td><strong>Eyes</strong></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>-</td>
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<tr>
<td>- draw almond shaped eyes</td>
<td>N</td>
<td>N</td>
<td>/ A</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>- The height of each eye to be about half its width</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>/ A</td>
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<tr>
<td>- left eye being reflection of the right eye across the central vertical line</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>/ A</td>
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<tr>
<td><strong>Nose</strong></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>-</td>
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<td>- draw an arc to indicate the tip of the nose</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>- draw an arc, starting from one diagonal line reaching the second diagonal line, to indicate the tip of the nose</td>
<td>N</td>
<td>N</td>
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<td>- symmetry between left and right side</td>
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<tr>
<td>- draw nostrils</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<td>- draw the outline for the nostrils starting and ending on the diagonal line</td>
<td>N</td>
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<tr>
<td>Mouth</td>
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<td>- draw a mouth</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>- draw a snake</td>
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<td>Y</td>
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486
<table>
<thead>
<tr>
<th>Eyeballs</th>
<th>Student 8</th>
<th>Student 9</th>
<th>Student 10</th>
<th>Student 11</th>
<th>Student 12</th>
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<tr>
<td>- draw eyebrows</td>
<td>Y</td>
<td>N/A</td>
<td>Y</td>
<td>N/A</td>
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<td>- the circle to be partly &quot;hidden&quot; by the top eyelid</td>
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<td>Y</td>
<td>N/A</td>
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<td>- round in shape</td>
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<td>N/A</td>
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<td>- leave a small white spot</td>
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<td>Y</td>
<td>N/A</td>
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<td>Y</td>
<td>N/A</td>
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<tr>
<td>- symmetry between left and right side</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N/A</td>
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<tr>
<td>- draw a hairline</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<td>- starting from the (bottom) point of the ear connected on the construction line</td>
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<td>Y</td>
<td>Y</td>
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<td>- line going upwards in a straight line to define the temples</td>
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<td>Y</td>
<td>Y</td>
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<td>- follow realistic shape according to the form of the forehead</td>
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<td>- symmetry between left and right side</td>
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<td>Y</td>
<td>N</td>
<td>N/A</td>
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<tr>
<td>- starting from a high point of the head (rear) ; draw the outline for the hair outside the circular construction line</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
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<td>Y</td>
<td>Y</td>
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<td>- start from the point were the bottom of the earlobe connects to the construction line</td>
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<td>Y</td>
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<td>- draw a distinct corner angle below the mouth line</td>
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<td>Y</td>
<td>N</td>
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<td>- draw the end of the chin with a horizontal line at least as long as the mouth</td>
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<td>Y</td>
<td>N</td>
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<td>N/A</td>
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<td>Student 2</td>
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<td></td>
<td>A B C D1 D2 E</td>
<td>A B C D1 D2 E</td>
<td>A B C D1 D2 E</td>
<td>A B C D1 D2 E</td>
<td>A B C D1 D2 E</td>
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<td>Mark location of facial features</td>
<td>0.5% 100%</td>
<td>0.5% 100%</td>
<td>0.5% 100%</td>
<td>0.5% 100%</td>
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<td>Understand size/ ratio of facial features</td>
<td>0.4% 75%</td>
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<td>0.4% 75%</td>
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<td>0.3% 100%</td>
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<tr>
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<td>0.3% 75%</td>
<td>0.3% 75%</td>
<td>0.3% 75%</td>
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<td>0.7% 87.5%</td>
<td>0.7% 87.5%</td>
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<td>0.2% 75%</td>
<td>0.2% 75%</td>
<td>0.2% 75%</td>
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<td>A B C D1 D2 E</td>
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488
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<td>C</td>
<td>D1</td>
<td>D2</td>
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<td>1/1 100%</td>
<td>1/1 100%</td>
<td>5/5 100%</td>
<td>5/5 100%</td>
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<td>3/4 75%</td>
<td>3/4 75%</td>
<td>2/4 50%</td>
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<td>4/4 100%</td>
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<td>1/1 100%</td>
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<td>5/8 63%</td>
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<td>4/5 80%</td>
<td>6/8 75%</td>
<td>6/8 75%</td>
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<td>8/8 100%</td>
<td>1/1 100%</td>
<td>1/1 100%</td>
<td>7/8 88%</td>
<td>7/8 88%</td>
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<tr>
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<td>4/4 100%</td>
<td>2/4 50%</td>
<td>2/4 50%</td>
<td>3/4 75%</td>
<td>0/4 0%</td>
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<tr>
<td>Ears</td>
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<td>5/5 100%</td>
<td>4/5 80%</td>
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<td>1/5 20%</td>
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**Notes:**
- X. Danos Ph.D. 2011

Appendices

**Table Data:**
- **A:** 48% 80%
- **B:** 46% 80%
- **C:** 46% 80%
- **D1:** 46% 80%
- **D2:** 46% 80%
- **E:** 46% 80%

**Legend:**
- **Task C:** 46% 80%
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<th>Mark location of facial features</th>
<th>Students 1-7</th>
<th>Students 8-12</th>
<th>Students 1-12 (%)</th>
<th>Students 1-12</th>
<th>Students 1-12 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Draw outline for the top half of the skull (diameter) by defining the centre and drawing a circle i.e. Ø500 cm</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2. Circle to have a constant radius (perfect circle)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>3. Draw a horizontal line to clearly define the middle of the circle</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>4. Draw a horizontal straight line (0°)</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5. Draw a vertical line to clearly illustrate the middle of the circle</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>6. Draw a vertical straight line (90°)</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>7. Draw vertical lines 1/12 of the diameter, inside each circle to define the distance between the ears</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>8. Draw straight vertical lines 30° (as described above)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>9. Divide the space between the two ears in 5 equal spaces i.e. 5 cm each</td>
<td>7/27</td>
<td>13/18</td>
<td>20/46</td>
<td>44%</td>
<td>7/27</td>
</tr>
<tr>
<td>10. Divide the circle into 5 equal in height sections i.e. 7.5 cm in height</td>
<td>25/40</td>
<td>15/26</td>
<td>40/46</td>
<td>59%</td>
<td>25/40</td>
</tr>
<tr>
<td>11. Add 2 more lines under the circle, using the same distance/height i.e. 5.7 cm each</td>
<td>20/27</td>
<td>15/20</td>
<td>35/47</td>
<td>75%</td>
<td>20/27</td>
</tr>
<tr>
<td>12. Mark the following: air line, eye, brows, eyes, ears, nose, lips and chin.</td>
<td>10/27</td>
<td>12/20</td>
<td>31/47</td>
<td>66%</td>
<td>10/27</td>
</tr>
<tr>
<td>13. Mark the width of the nose by drawing a triangle from the centre of the circle through to the 3rd &amp; 4th vertical mark</td>
<td>18/27</td>
<td>13/20</td>
<td>31/47</td>
<td>66%</td>
<td>18/27</td>
</tr>
<tr>
<td>14. Construction lines drawn lightly</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Understand size/ratio of facial features</td>
<td>Students 1-7</td>
<td>Students 8-12</td>
<td>Students 1-12 (%)</td>
<td>Students 1-12</td>
<td>Students 1-12 (%)</td>
</tr>
<tr>
<td>The length of an eye should fit 5 times along the length of the head</td>
<td>20/27</td>
<td>14/18</td>
<td>34/46</td>
<td>74%</td>
<td>20/27</td>
</tr>
<tr>
<td>The ear starting line with the eyes and ends at the tip of the nose</td>
<td>17/27</td>
<td>8/19</td>
<td>25/46</td>
<td>54%</td>
<td>17/27</td>
</tr>
<tr>
<td>Draw the correct width of the nose based on the construction line</td>
<td>9/27</td>
<td>7/19</td>
<td>16/46</td>
<td>35%</td>
<td>9/27</td>
</tr>
<tr>
<td>Draw the correct length of the mouth based on the construction line</td>
<td>17/27</td>
<td>9/19</td>
<td>26/46</td>
<td>57%</td>
<td>17/27</td>
</tr>
<tr>
<td>Drawing the facial features</td>
<td>Eyes</td>
<td>Students 1-7</td>
<td>Students 8-12</td>
<td>Students 1-12 (%)</td>
<td>Students 1-12</td>
</tr>
<tr>
<td>- draw eyes</td>
<td>40/40</td>
<td>28/26</td>
<td>68/68</td>
<td>100%</td>
<td>17/27</td>
</tr>
<tr>
<td>- draw almond shaped eyes</td>
<td>17/27</td>
<td>15/19</td>
<td>32/46</td>
<td>70%</td>
<td>17/27</td>
</tr>
<tr>
<td>- The height of each eye to be about half its width</td>
<td>25/27</td>
<td>16/19</td>
<td>41/46</td>
<td>86%</td>
<td>25/27</td>
</tr>
<tr>
<td>- half eye being reflection of the right eye</td>
<td>22/27</td>
<td>18/10</td>
<td>38/46</td>
<td>83%</td>
<td>22/27</td>
</tr>
<tr>
<td>- Nose</td>
<td>Students 1-7</td>
<td>Students 8-12</td>
<td>Students 1-12 (%)</td>
<td>Students 1-12</td>
<td>Students 1-12 (%)</td>
</tr>
<tr>
<td>- draw indicate a nose</td>
<td>40/40</td>
<td>28/26</td>
<td>68/68</td>
<td>100%</td>
<td>39/40</td>
</tr>
<tr>
<td>- indicate the tip of the nose</td>
<td>39/40</td>
<td>28/26</td>
<td>67/68</td>
<td>99%</td>
<td>39/40</td>
</tr>
<tr>
<td>- draw an arc to indicate the tip of the nose</td>
<td>25/40</td>
<td>15/26</td>
<td>40/46</td>
<td>59%</td>
<td>25/40</td>
</tr>
<tr>
<td>- draw an arc, starting from one diagonal line reaching the second diagonal line, to indicate the tip of the nose</td>
<td>6/27</td>
<td>5/19</td>
<td>11/46</td>
<td>24%</td>
<td>6/27</td>
</tr>
<tr>
<td>- symmetry between left and right side</td>
<td>17/27</td>
<td>10/19</td>
<td>27/46</td>
<td>59%</td>
<td>17/27</td>
</tr>
<tr>
<td>- draw nostrils</td>
<td>3/40</td>
<td>2/26</td>
<td>6/46</td>
<td>94%</td>
<td>3/40</td>
</tr>
<tr>
<td>- draw line outline for the nostrils starting and ending on the diagonal line</td>
<td>0/40</td>
<td>2/26</td>
<td>2/66</td>
<td>4%</td>
<td>0/40</td>
</tr>
<tr>
<td>- symmetry between left and right side</td>
<td>18/27</td>
<td>11/19</td>
<td>29/46</td>
<td>63%</td>
<td>18/27</td>
</tr>
<tr>
<td>Students 1-12</td>
<td>Students 8-12</td>
<td>Students 1-12 (%)</td>
<td></td>
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<tr>
<td>--------------</td>
<td>--------------</td>
<td>------------------</td>
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<tr>
<td><strong>Eye Area</strong></td>
<td></td>
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<td>- draw the eyes</td>
<td>35/40</td>
<td>28/38</td>
<td>86%</td>
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<tr>
<td>- the circle to be partly hidden by the top eyelid</td>
<td>34/37</td>
<td>19/28</td>
<td>55/85</td>
<td>85%</td>
<td></td>
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<tr>
<td>- round in shape</td>
<td>35/37</td>
<td>19/28</td>
<td>55/85</td>
<td>77%</td>
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<tr>
<td>- leave a small white spot</td>
<td>12/19</td>
<td>3/5</td>
<td>23/85</td>
<td>38%</td>
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<tr>
<td>- the distance between the circle and the left side of each eye to be the same</td>
<td>34/37</td>
<td>19/28</td>
<td>55/85</td>
<td>77%</td>
<td></td>
</tr>
<tr>
<td>- symmetry between left and right side</td>
<td>30/37</td>
<td>19/28</td>
<td>46/85</td>
<td>71%</td>
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<tr>
<td><strong>Hairline</strong></td>
<td></td>
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<tr>
<td>- draw a hairline</td>
<td>40/40</td>
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<td>88/88</td>
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<tr>
<td>- starting from the (bottom) point of the ear connected on the construction line</td>
<td>31/40</td>
<td>23/28</td>
<td>54/88</td>
<td>79%</td>
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<tr>
<td>- line going upwards in a straight line to define the temple</td>
<td>21/40</td>
<td>19/28</td>
<td>40/85</td>
<td>59%</td>
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<tr>
<td>- follow realistic shape according to the form of the forehead</td>
<td>20/40</td>
<td>22/28</td>
<td>42/85</td>
<td>71%</td>
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<td>- symmetry between left and right side</td>
<td>11/37</td>
<td>12/19</td>
<td>23/85</td>
<td>41%</td>
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<td>- starting from a high point of the cheek, draw the outline for the hair outside the circular construction line</td>
<td>23/40</td>
<td>16/28</td>
<td>39/88</td>
<td>57%</td>
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<tr>
<td><strong>Jaw</strong></td>
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<tr>
<td>- draw a jaw</td>
<td>38/40</td>
<td>27/28</td>
<td>66/88</td>
<td>100%</td>
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<td>- start from the point where the bottom of the ear connects to the construction line</td>
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<td>23/28</td>
<td>59/88</td>
<td>85%</td>
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<td>- draw a distinct corner angle below the mouth line</td>
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<td>57%</td>
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<td>- draw the line of the chin with a horizontal line at least as long as the mouth</td>
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<td>17/19</td>
<td>29/88</td>
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<td>44%</td>
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<td>Location of Facial Features</td>
<td>Understand Size/Ratio of Facial Features</td>
<td>Eyes</td>
<td>Nose</td>
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<td><strong>C</strong></td>
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<th>B</th>
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<th>D1</th>
<th>D2</th>
<th>E</th>
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<th>B</th>
<th>Task C</th>
<th>D1</th>
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<td>-</td>
<td>-</td>
<td>4/8</td>
<td>50%</td>
<td>-</td>
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<td>3/4</td>
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<td>0%</td>
<td>3/5</td>
<td>60%</td>
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<tr>
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<td>100%</td>
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<td>100%</td>
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<td>2/4</td>
<td>50%</td>
<td>3/4</td>
<td>75%</td>
<td>2/2</td>
<td>100%</td>
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<td>1/4</td>
<td>25%</td>
</tr>
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<td>6/6</td>
<td>100%</td>
<td>1/1</td>
<td>100%</td>
<td>7/8</td>
<td>87.5%</td>
<td>7/8</td>
<td>87.5%</td>
<td>1/4</td>
<td>25%</td>
<td>3/4</td>
<td>75%</td>
<td>2/4</td>
<td>50%</td>
<td>2/4</td>
<td>50%</td>
</tr>
<tr>
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| | 12= | 83.3 | 10= | 68.9 | 2= | 70.9 | 100/12= | 83.3 | 110/2= | 91.7 | 650/10= | 65 | 400/10= | 65 | 700/2= | 58.3 | 100/2= | 83.3 | 100/10= | 83.3 |

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Annexes

Annex 1: 1026 photographs taken in Cyprus during Pilot study 1 for the analysis of textbooks

Annex 2: 400 photographs taken in the USA during Case study 1 for the analysis of textbooks

Annex 3: 369 photographs taken in the UK for the analysis of textbooks

Annex 4: Students' work from the workshops (Pilot study 2) on rendering, perspective, and logo design

Annex 5: Handouts with images providing inspirational materials for drawing cartoons and caricatures with a focus on facial expressions used in Case study 4

Annex 6: Delphi study group initial email used to contact 18 people

Annex 7: Signed (by teachers) consent forms following the ethical guidelines required during interviews (available upon request)

Annex 8: Teachers' audio recorded interviews (available upon request)