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Design Decisions in Design and Technology Education: A research project undertaken in Cyprus, Iceland, and England

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Abstract

The paper represents a research project on design decision-making in the area of design and technology education in Cyprus, Iceland and England. This was carried out in 2006-7 and explored the role of teachers and their understanding for the importance of students' autonomy in decision-making when they are at age 11-14. In addition the paper looked at the congruity between decision-making opportunities included in national curricula and how teachers understand the relationship between such curricula and practice. The data collection is based on semi-structured interviews with teachers from Cyprus, Iceland and England, and reviews of the national curricula. In the study, the researchers compared their findings and reached common conclusions. This initial study articulated understanding gained from teachers of their practice and hence provides the foundation for an action research programme and further comparative studies. However, some discussions of possible improvements to practice in design decision-making within design and technology education are also included in the paper.

Key words

design decisions, design and technology, national curricula, comparative studies

Introduction

National curricula for general education, in many countries, aim to increase children's ability to make their own decisions (Davis, 2004). Design and technology education as part of general education in many countries, offers decision-making opportunities through designing and making activities, which can enhance students' skillfulness in making their own decisions in daily life. Despite the importance of the improvement of decision-making skills in young children, few research studies have identified the importance of the teachers' role in guiding children.

The current study explores the beliefs and attitudes of design and technology teachers' from Cyprus, Iceland and England about their practice with children while taking design decisions. The research is at an initial stage and may lead to a wider comparative study of practice in this area. The paper presents findings concerning teachers' understanding and attitudes towards their capability to support the development of students' design decision-making skills. Research outcomes concerning teachers' reports of their implementation of curriculum in order to increase students' skills are also given.

As the foundation for an action research programme, this study was conducted to establish a starting point founded on current best practice. It is important to understand how cultural differences may affect teachers' ideas about decision-making and consequently a comparative study of practice was designed. England was selected as a country where design and technology education is well established in the national curriculum, and the English model has inspired many other countries to establish similar subjects. Cyprus and Iceland are both small islands that were influenced in a way by the English model of design and technology, and which might reveal such cultural differences.

The paper firstly explores the theoretical background about decision-making, and then looks at the specific model for design and technology education in Cyprus, Iceland, and England. The objectives in the different curricula are reviewed and the methodology for the enquiry is described. The outcomes of interviews with teachers are then reported and discussed.

Theoretical Background

Decision-making refers to choosing between possible alternatives and this process is part of everyday activities. In design and technology many activities include alternative choices that might affect the outcome (Jimenez-Aleixandre and Pereiro-Munoz, 2002). Kortland (1996) identified rational decisions as reasoned choices, built on criteria that are not formulated from the beginning, but developed in interaction with the evaluation of the choices available.

Many research outcomes relevant to decision-making come from the area of cognitive development (Sternberg, 1996; Birnbaum, 1998; Baron, 2000) or the areas of operational research, economics and management (Bazerman, 2005; Gibson et. al., 1997). In the field of educational research, decision-making strategies have only recently gained significant attention, with most of the studies related to science education (Patronis et. al. 1999, Kolstø, 2001). In design and technology education, there exist only few studies concerning decision-making (Davies, 2004; Coles & Norman, 2005, Mettas & Constantinou, 2006a, Welch, Barlex & O'Donell, 2006). Davies (2004) argues that children's design decisions play an important role in developing their understanding of the relationship between technology and society. Coles & Norman (2005) suggests that values have an important role in design decision-making. Mettas & Constantinou (2006b) explore the development of decision-making skills of pre-service teachers through a Technology Fair project. Welch, Barlex & O'Donell, (2006) investigated elementary students' beliefs about designers and designing with an emphasis on design decisions.

In design and technology decisions are required almost at every step of designing; when we are evaluating alternative solutions or we are selecting from the range of appropriate materials we have to make decisions quickly and effectively (Davies, 2004). Such decisions relate to the kind of materials and processes to use, the kind of artefact they produce, whether their proposed solution involves hazardous processes, or will have features that might be dangerous for the user of the product (Middleton, 2005). During the development of the solution, values are an inescapable, if not always an overt part of the learning activities (Coles & Norman, 2005). Decisions could be affected by preferences, opinions, emotions, cultural characteristics etc, and therefore technological activities can rarely be entirely free of value judgments.

Very frequently technological decisions are not straightforward, i.e. there is no option that fulfils all the requirements better than others. For example, Prime (1993) argues that:

> 'Technology often poses real ethical dilemmas in which there are no obvious right answers or altogether satisfactory solutions. In such cases the challenge is to weigh all relevant contextual factors and to be guided by the values deemed to be more important in that situation.' (32).

Kimbell et al. (1996) pointed out that in technology education programs, "little attention has been given to the discursive practices of justifying trade-offs, arguing for selection among alternative acceptable solutions, or persuading collaborators to contribute to a specific line of work" (25). Therefore there is a need to investigate in more depth how children actually take their design decisions and how teachers support them during that process.

Brief description of design and technology education in Cyprus, England and Iceland

Design and technology education in Cyprus was introduced in 1992 and replaced a craft based subject. Children were to be given the opportunity to 'design and make' products using mainly resistant materials and produce systems involving electric/electronic circuits, mechanisms, pneumatics and structures. The subject is compulsory for children in primary schools age 5-10, for children in lower secondary school, age 11-14, and for the first grade of higher secondary school, age 15 and is optional for second and third grade of higher high school, age 16 and 17.

Design and technology in England was introduced in 1990 following development over a number of years, and with an emphasis on designing and making activities. In design and technology classes, children are expected to combine practical and technological skills with creative thinking to design and make products and systems to meet human needs. Such learning about available material and technologies is expected to support their participation in developing positive attitudes about technology. Design and technology in England is compulsory for Key Stage 2 (ages 7-11) and Key Stage 3 (ages 11-14) and is optional for Key Stage 4 (age 14-16).

The Icelandic 'Craft' subject was re-established as a new technological subject in 1999, based on a rationale for technological literacy, innovation and design. The new subject 'Design and Craft' was influenced by the national curricula of New Zealand, Canada and England and a specific Icelandic model for Innovation Education. Design and Craft education is compulsory for all grades 1-8 (ages 6-13), but optional for grades 9-10 (ages14-15). In the subject students base their ideation on authentic problems and design and make their artefacts from resistant materials and they design systems based on electric/electronic circuits, mechanisms, pneumatics and structures.

In England, design and technology includes home economics (food technology and textiles), whereas in Cyprus and in Iceland home economics and design and technology are separate subjects. For the purposes of the current study the curricula of Key Stage 3 (age 11-14) in England, the lower secondary education (Gymnasium, age 11-14) in Cyprus and grades 7-9 (age 11-14) in Iceland have been compared in terms of decision-making opportunities provided to students in design and technology.

Research Questions

The research questions of the study were:

(i) What decision-making opportunities are included in design and technology curricula in Cyprus, Iceland and England?

(ii) What decision-making opportunities do teachers from Cyprus, Iceland and England give to children when working on design and technology activities?

(iii) What are the similarities and differences of Cypriot, English and Icelandic teachers' ideas about decision-making skills in design and technology education?

Methodology

The study was carried out in two phases. The first phase included the review of the design and technology curriculum in each country and the second phase included interviews with four teachers in each of the three countries in order to shed further light on some areas of practice. These semi-structure interviews were designed to explore issues like teachers' implementation of national curricula, the effect of books and other sources of information on children's design decision-making, and the ability of children to set criteria for evaluation and to transfer skills to other areas of life. The interviews were conducted in Greek, English and Icelandic and have been translated into English by the researchers.

A common schedule was constructed for the interviews based on literature review and observations of documents from the teachers' classes. The aim was to explore the attitudes and strategies that under-pinned their practice. The interviews were recorded on a digital recorder and transferred to a computer, in order to facilitate the process of analysis. Recording interviews can potentially make the respondents less relaxed, but has the advantage of preserving a more complete record of the interview than would be possible when taking notes (Smith, 1995, Willig, 2001).

The research was conducted through a phenomenographic approach because of its appropriateness to the investigation of a phenomenon such as decision-making. Phenomenography aims to describe, analyse and understand the ways in which people experience aspects of the world around them. The point of departure that sets apart this approach from many others, is the principle that phenomenography seeks to investigate neither the phenomenon, nor the people who experience the phenomenon, but the relation between the two. The results of a phenomenographic study are presented as a description of all of the possible conceptions that a specific group can have about a particular phenomenon (Marton & Booth, 1997), in this case children's decision-making capabilities in design and technology classes.

Sample

The authors conducted semi-structured interviews with open-ended questions with four individual teachers from the three participating countries. All of the selected teachers were in the early stages of their career with sufficient experience to understand current practice in this area, but still formulating their own perspectives. This was considered to be the group most likely to reveal both current practice and those areas of it that were less securely based.

Research Outcomes

Two major outcomes emerged from the research are related with the comparison of the decision-making opportunities within the design and technology curricula of Cyprus, England and Iceland and the major findings from the interviews with teachers.

Design and technology in the curricula of Cyprus, England and Iceland

The role of technological knowledge, i.e. electronics, mechanisms, control etc. is acknowledged in all countries, but plays a more significant role in the Cypriot curriculum. Some representative objectives for each level were selected from each country and presented in the following tables in order to indicate the different requirements.

11-12 years old	12-13 years old	13-14 years old
Analyse simple products and describe possible design decisions taken by manufacturers.	Analyse existing mechanical products and describe possible design decisions taken by manufacturers.	Analyse existing electric products and describe possible design decisions taken from manufacturers.
Decide the purpose of simple constructions that introduce children with basic materials.	Decide and describe a simple technological problem that is possible to be solved with simple mechanisms (gears, pulleys, cams, crank and slider etc.).	Decide and describe a simple technological problem that is possible to be solved with electronics.
Children should search information and decide upon the appropriate shape, materials, size, strength, use, decoration etc. of their project.	Decide the appropriate appearance, mechanism and decoration for moving picture with levers and linkages.	Choose the appropriate components for the input, process, and output of an electronic system. Inputs: LDR, thermistor moisture sensor, switches. Process: transistors, Darlington pair, thyristor. Outputs: light bulb, buzzer, motor, loudspeaker, LEDs.
Evaluate and judge if the artefact you made satisfies the specification of the project.	Evaluate and judge if the mechanical system you design satisfies the specification of the project.	Evaluate and judge if the electric system you designed satisfies the specification of the project.

Table 1. Objectives from the Cypriot National Curriculum

11-12 years old	12-13 years old	13-14 years old
Sharing decisions with the teacher and others.	Working independently on a task determined by the teacher.	Working independently on a chosen task.
Evaluating strengths and weaknesses – how well does it work?	Explain the choices and decisions made in designed and manufactured products.	Prioritising and reconciling decisions on materials, time and production.
Find and select information which informs and clarifies thinking about the task.	Discuss, debate, question and challenge information and the nature of the task itself.	Select information sources, gathering and sorting data that will help with decisions about, the design.
Explore and experiment with and then select appropriate materials and processes.	Find out what materials and components are available and use technical information to decide on their suitability for the task.	Make and justify decisions regarding the choice of materials and manufacturing processes and use them to draw up a manufacturing specification.
-	Justify decisions made in the selection of materials and methods of making.	Identify any design weaknesses in the choice of materials and manufacturing processes.

Table 2. Objectives from the English National Curriculum

12 years old	13 years old	14 years old
Be able to work independently through a design process.	Think about the value of artistic outlook in their design when they make their choices.	Take ergonomic issues into account when they make their design decisions.
Identify needs and problems in their environment before taking their design decision.	Define a need and establish a main concept and develop it by focusing in its functionality and usefulness in the society.	Work though a design process based on own specific concept. They should be able to discuss their work with their co-students when making their design decisions.
Base their design decision on solving a need and design an artifact to show the outcome.	Identify needs and problems in society though own observation before choosing their solution.	Show initiative and be autonomous in their design work. They also have to be able to seek for and apply knowledge by using ICT.
Make their own design drawings in order to come to a decisions about possible solutions.	Show their chosen solution in a form of an artifact made from solid material.	Take sustainability into account in their design decisions.
Base their design choices on technical solutions and focus on the artifacts functionality.	Make design drawing of his/her solutions when making their choices.	Evaluate their design and be able to argue about its quality.

Table 3. Objectives from the Icelandic National Curriculum

Interviews Outcomes

The interviews were analysed with the phenomenographic approach developed by Marton (1981). Phenomenographic interviews are typically tape recorded and transcribed verbatim, making the transcripts the focus of the analysis. Phenomenographic analysis is often described as a process of 'discovery' (Hasselgren and Beach, 1997), in the sense that the set of categories or meanings that result from the analysis cannot be known in advance but must *emerge* from the data through the analysis; a process clearly influenced by the values of the researchers themselves. Teachers' ideas about children's decision-making capabilities were analysed and categorised in relation to the research questions. The main similarities and differences both between teachers from the same, and from different countries, are presented below.

From the analysis of the results it can be observed that during the first stages of secondary school (age 11-12) teachers set quite rigid tasks to children that give very few decision-making opportunities. Teachers believe that young children (age 11-12) need to work with very structured tasks in order to gain basic designing skills. As they progress they are giving more complex tasks and more choices, therefore providing more decision-making opportunities to children. This outcome was identified both with teachers from Cyprus, England and Iceland. For example a Cypriot teacher said during his interview "In the age of 11, I normally set tasks that are giving fewer opportunities for decision-making because children are inexperienced, and need the teacher to give them very frequent guidance and feedback". Similar responses were identified with English teachers, for example "With younger children, Years 7 to 8 (aged 11-13) we structure the projects so that any major decisions – those related to the manufacture of the object – are already stated in the project. Similar ideas were expressed by the Icelandic teachers. For example a teacher said: "I have more requirements from older students as they have learned working with design and technology processes, but with younger children most of the times the project is mainly driven by the teacher".

Teachers from Cyprus, England and Iceland expressed the belief that the curricula in all countries include decision-making opportunities, but in practice it is difficult to apply those decision-making opportunities with children due to many limitations (time, resources and children's abilities). For example a Cypriot teacher argues that "The guidelines of the national curriculum are giving many opportunities to teachers to set decision-making tasks. Despite that in practice, time limitations

minimize those opportunities". Similar beliefs were also expressed by English teachers, one of them said that: "The curriculum does allow opportunities for design decisions but these may be limited by resources available or what is practical in a lesson". Icelandic teachers also complained about too little time for the subject in order to train the students according to curriculum requirements, e.g. "The curriculum is too complicated and asks for too much of the teacher as the time is too little".

One important element before any decision-making is the ability to seek information in order to improve their knowledge to support the design decision. Cypriot teachers expressed the idea that most children do not recognize the need to collect relevant information before they take their design decisions, especially during early years, e.g. "I think that children are not using a range of information sources for their design decisions. They mainly use their textbooks, but very rarely will look for additional books". According to Cypriot teachers, the sources of information that children mainly use, is the guidance of their teachers and the next most important source of information is peer influence within their class. Some other sources of information mentioned by Cypriot teachers include projects from past year's students, internet sources and their existing knowledge, built from previous projects and skills exercises.

English teachers seem to believe that only some children recognise the need to collect information before taking some important design decisions. For example an English teacher said: "Some [children] are able to take the information they are given and produce work independently, whereas others struggle with this and need a lot more focused help". The source of information that is considered to be most important for English children is also the guidance of their teachers. Some other sources mentioned by English teachers were: internet websites, projects from past year's students, modelling, product analysis and their own knowledge, built from previous projects and skills exercises.

The Icelandic teachers were using the internet as the main source of information, but said there was a lack of on-line teaching material. The teacher seems to have a less important role as a source of information within Icelandic education.

According to teachers from all three countries, the majority of books that are in use in design and technology classes do not include many decision-making opportunities, e.g. a Cypriot teacher said: "The textbooks that are used for secondary education don't include many opportunities for decision-making. Their main aim is to serve as textbooks that children will have the opportunity to use them and gain knowledge and information that will be important and helpful in their decision-making". By the same token, English teachers expressed similar opinions, for example a teacher said: "Many of the books that we use for design and technology teaching are extremely focussed on delivering information". Some of the Icelandic teachers were using English design and technology books but they reported the difficulty for children in collecting information autonomously from the books. For example a teacher said: "Some of the students like me to explain for them how to do everything before they start. Sometimes I help them too much but I have to get them started".

Teachers from both countries express the belief that children have many difficulties in setting appropriate criteria in order to evaluate their available options. For example when children are asked to evaluate possible options it is very difficult for them to set any criterion further than attractiveness. A Cypriot teacher said: "I think that students most of the times don't set certain criteria to evaluate their design decisions", similarly an English teacher said: "I find that the younger children identify obvious attributes related to the aesthetics, style and function of the product, however as they get older they can also bring in more subtle criteria, i.e. ergonomics. The main area that is affected though is the ability to justify and explain their opinions and reasons for including criteria for evaluation. The younger the student the harder they find it to include the detail and justification required". The Icelandic teachers referred to the innovation part of the curriculum as an area where it was very helpful for students to use criteria based on problem-solving. They also express the idea that students use the internet to help them specify criteria, for example a teacher said: "Many establish their criteria by using the internet and look inside of themselves to find want they want to make".

During interviews all teachers identified some difficulties that children face in their effort to make rational design decisions. A Cypriot teacher argue that: "The main difficulty is that children are asked to make a decision without giving them any formal instruction". Another difficulty that was identified from interviews is that children don't have the motivation to think in-depth about their design decisions, and as a result they decide without exploring all the available options or the information needed. The lack of motivation during their design decisions was also identified from English teachers, for example "The main problem we have is that children do not want to spend time designing their product and researching possible solutions. Most would rather rush straight into making, and we have to stop them and give them structured design tasks to follow". The Icelandic teachers mentioned the importance of training the students and being connected to the innovation part or the curriculum.

Teachers seemed to feel unsure as to whether decision-making skills learned within design and technology classes, are transferable to other subjects or other daily activities (such as personal purchasing). For example a Cypriot teacher said: "I am not sure about the ability to transfer skills, but I believe that this can be the case only for a few children. As they grow older maybe children are more able to transfer their skills to everyday activities". English teachers have similar doubts concerning the children's ability to transfer skills, for example one of them said: "I am not sure, I would hope so, as we do gain more experience, but I don't think there is a direct link to skills learnt in class". Icelandic teachers talked about creative thinking as a very positive life skill. A teacher said "I don't know, this has to be researched in more depth mainly by the academic researchers".

Discussions

From the review of the curricula it can be observed that the English and Icelandic curricula are framed more in process terms when compared to the Cypriot curriculum. Designing and making provide the philosophy of the curriculum, from which knowledge is supported. The approach of the Cypriot curriculum is more content oriented and the subject is usually conceived in terms of major sub-divisions, such as communications, mechanisms, electronics, structures, and energy. Design decisions have to be taken within a specific domain (for example electronics). Nevertheless the curriculum guidelines for England and Iceland both require decision-making opportunities to be provided in technological contexts. For example: "Make and justify decisions regarding the choice of materials and manufacturing processes and use them to draw up a manufacturing specification" (English NC, age 15), or "Choose the appropriate components for the input, process, and output of an electronic system" (Cypriot NC, age 15). The Icelandic curriculum specifies less design decision requirements and relies more on a general form of a design process with the emphasis on innovation.

During children's early designing activities, aesthetics of the product seem to be more important than the manufacturing or the construction of the product. This outcome is acknowledged by all the teachers interviewed (from Cyprus, England and Iceland), e.g. a teacher from England said "Mainly they [children] must decide what the item will look like". As children grow up and gain more experience teachers give them more design decision-making opportunities.

Teachers from the three countries expressed the opinion, that some children expect everything to be done for them and that they are not used to thinking for themselves and therefore find decision-making difficult. They use their past experiences from previous years and their textbooks to decide mainly about the appropriate materials.

According to some teachers as children progress, they should be given more decision-making opportunities to identify their own tasks and activity, and should use their knowledge and skills to make decisions which are more complex, or satisfy more demanding needs. This outcome was observed as well in earlier research by Webster (1990) in a comparative study between design and technology in England and France.

Most of the teachers do not offer any kind of formal instruction on decision-making techniques to their students. It seems that children are expected to take design decisions without being given any training to develop this complex skill. A Cypriot teacher said during his interview: "I am not giving them any formal instruction, just some general guidelines that they have to follow in order to make effective choices". Similar responses were also identified from English and Icelandic teachers. For example an English teacher said: "At a younger age I tend to advise students on the best course of action whereas with older students I tend to make suggestions but allow them to discover the results of their design decisions".

The majority of children rarely search for information outside the class before taking their design decisions. The main source of information for Cypriot and English children is their teacher and this is more obvious at younger ages (age 11-12) than later on (age 14-15). However, teachers from Iceland said that their students use the internet as the main source of information for their design decisions. Other sources of information that children use to support there decisions includes, peer influence, existing designs from previous students and technical books.

An obstacle that children face during decision-making is their inability to set appropriate evaluation criteria for their design decisions. This difficulty was identified in previous research (Mettas and Constantinou, 2006a) with slightly older students (age 18). Another difficulty identified from the research is the lack of motivation that children might have during decision-making. Children do not acknowledge the importance of spending time on designing their project and they like to move to the making part.

It is likely that explicit teaching of decision-making skills by teachers might enable children to develop their ability to handle complex design decisions earlier, although the challenge remains as to how such designing can be developed to provide the same motivation as making.

Conclusions

Decision-making skills are an important part of our everyday activities. Therefore general education should give the opportunity to children to develop such skills. Despite the small sample of the study some interesting conclusions can be drawn.

From the results of the study it can be concluded that curricula in Cyprus, England and Iceland include many opportunities for decision-making in design and technology classes. However in practice teachers believe that some of the requirements of the curricula are not feasible to apply. Another potentially significant outcome for curriculum developers is that children very rarely search for information, or set appropriate criteria to support their design decisions. Children rely on teachers and past experience in order to reach decisions, and explicit requirements to develop decision-making capabilities could well improve the curricula in all three countries.

Associated formal training in decision-making techniques might also improve the quality of children's decisions during design activities.

Another important issue is that there is a positive motivational effect when children take design decisions, and there is an improvement in their participation in their design project, when it is something meaningful to them. This finding echoes those of many other researchers.

Comparative studies between different countries can offer an excellent framework to develop awareness about the development of children's decision-making skills. This study is the first phase of a larger research project that aims to improve our understanding about children's decision-making capabilities in design and technology education and researchers from other countries would be welcome to join our efforts in this important and complex area.

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