Post-16 design and technology project work: what are students learning and what is being assessed?

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Post-16 Design and Technology Project Work: What are students learning and what is being assessed?

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Abstract

Several sources, such as the Office for Standards in Education (OfSTED) reports and Data News, record the continuing success of post-16 design and technology (D&T). However, there has been a recent debate within the profession about creativity within D&T and how it can be assessed. This apparent success and its links to the creativity debate prompted this research.

Analysis of an AS/A2 specification using Gagne’s categories of capability indicates a comprehensive learning experience for students. Gagne (1985) defines five categories for capability, he refers to these collectively as Varieties of capability. Initially this paper explores how these can be applied to the post-16 D&T learning experience.

To gain further insight into post-16 D&T three survey research methods outlined by Wiersma (2000), were used. The first concerned collecting data from teachers by a rapid response questionnaire titled ‘Less than a minute of your time’. The second was through semi-structured interviews of students who had recently completed their D&T A’ level course. Thirdly triangulation was introduced by the researcher working with a group of AS level students engaged in project work.

The findings indicate that assessment criteria in examination specifications could be limiting learning opportunities particularly where subject knowledge is applied within project work. There is variation in teachers’ views of present assessment criteria, many indicating that they would like to apply assessment criteria which reflect the more creative aspects of D&T.

Key words
design and technology, D&T, post-16, AS/A2 level D&T, teaching and learning, capability

Context

In England post-16 design and technology (D&T) continues to develop and is attracting an increasing number of students. Table 1 shows the increase since 2002.

Additionally, the Office for Standards in Education (OfSTED) reports (2005:3) the following good pass rates: 'At Advanced Subsidiary (AS) level, 88.1% of candidates attained a pass grade, the same as last year. In the Advanced Level General Certificate of Education (A2), 96.2% of candidates attained a pass grade compared with 95.8% last year.'

However, it is concerning that the number of students gaining the top A/B grades is low at 40% when compared with subjects such as physics: 50%, art and design: 52%, geography: 51% and mathematics: 62%. (Data News 2006:14)

During the period 2002 to 2005, the examination specifications have been developed. All A’ level D&T specifications now have a clearly defined modular structure which typically is represented by the model shown in Table 2 provided by the Oxford, Cambridge and Royal Society of Arts (RSA) Examinations (OCR) Awarding Body. In England post-16 specifications are divided into the one year Advanced Supplementary (AS) course which is then followed by the one year Advanced General Certificate level, often referred to as A2.

<table>
<thead>
<tr>
<th>Year</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>Percentage increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>D&amp;T A’ level candidates</td>
<td>10042</td>
<td>11413</td>
<td>17747</td>
<td>18225</td>
<td>45%</td>
</tr>
</tbody>
</table>

Table 1: Increase in A’ Level D&T entries (Data from Data News Jan 2004:13 and Jan 2006:14)
Gagne (1984: 46-67) provides a useful analysis tool with his ‘five varieties of learned capabilities’ which are listed below.

- **Intellectual Skills** – this is ‘knowing how’ to do things, or procedural knowledge. In the context of D&T this includes, for example, knowledge of materials, tools and processes for specific applications.

- **Verbal information** – this is a capability concerned with how to communicate what a person knows. A person should be able to state or tell a fact using writing or words. However in D&T we need to add drawing, prototyping, sketching, indeed any kind of presentation work produced by students would come into this category.

- **Cognitive strategies** – this capability can be described as learning how to think. Cognitive strategy is a capability which the learner acquires through managing their own learning.

- **Motor Skills** – Gagne’s clear definition is a capability to perform physical actions with purpose. He gives examples (1984:48) of threading a needle or throwing a ball. In the D&T context this capability is concerned with the extensive range of practical skills.

- **Attitudes** – is capability to develop preferences or an affinity for a certain subject or specialism. In D&T this forms the basis for developing expertise in working with a particular material, technology or developing aesthetic preferences.
Using these ‘capability categories’ as analysis tools for the OCR specification it is possible to focus on the category of capability being developed in each module. The analysis consisted of scrutiny of the content, the type of assessment and the criteria for assessment. Table 3 shows the results of this analysis.

Analysis of the OCR specification ‘Advanced GCE in Design and Technology (7822) Third Edition’ indicates that some modules are designed to enable students to build a range of capabilities while others are more narrowly focused on knowledge and understanding of D&T processes and procedures. From the analysis, it can be seen that modules 2522 Designing and 2523 Making and Evaluating (essentially a double module) provide opportunity for students to develop all five of Gagne’s capabilities. 2519 Product Study: Analysis and Development has a similar function, but at AS level this is less comprehensive. However, the specification repeatedly indicates that the module dedicated to the ‘intellectual skills’ of building knowledge and understanding (2520 Product Design 1) are designed to contribute to modules 2522 Designing and 2523 Making and Evaluating. Strengthening the intellectual skills, of the specification goes some way to addressing the concerns of university engineering degree course admission tutors and/or course leaders who previously expressed concerns about the consistency of the body of knowledge within the previous A’ level design specification (Lewis, 2001:81-83).

The issues explored by the research
Three issues are explored in this research:
• the effectiveness of the current AS/A2 structure;
• student learning experiences at AS/A2 level;
• the match between teachers’ views and priorities of assessment criteria.

Research methods
Data was gathered by three methods, the first being semi-structured interviews with successful A’ level students who had just entered higher education. The second was participant observation, when the researcher joined a group of AS students as a participant observer. Finally a questionnaire survey of teachers’ priorities regarding the assessment of AS/A2 level project work.

Semi-structured interviews
Twenty-four first year undergraduates were interviewed about their experiences of doing post-16 project work in school. Thirteen were enrolled as design students and eleven as D&T initial teacher education students. All had satisfactorily completed A’ level D&T. According to Cohen et al (2000), in a semi-structured interview ‘the topics and open-ended questions are written but the exact sequence and wording does not have to be followed with each respondent’. The process of the interview involved the recording of details of their experiences as they worked through an A2 level D&T project. The aims were to explore the student learning experience at AS/A2 level and to establish their level of knowledge and understanding of specific aspects of designing and making, particularly how they developed that understanding or capability. The aspects considered were: developing a design specification; communication and visualisation; selection of materials; selection of manufacturing processes; working creatively and producing a quality product. These aspects were selected from the assessment criteria issued for the OCR modules Designing and Making and Evaluating.

These aspects were selected from the assessment criteria in the specification on the basis of providing interviewees with opportunities for discussion. For example ‘developing a design specification’ is categorised as an element of a complex set of criteria ‘Recognition, Investigation and Synthesis of Design Opportunities’ (2004). Scrutiny of all the assessment criteria used in modules 2522: Designing and 2523: Making and Evaluating reveals that they can be categorised into two board groupings which the researcher describes as ‘procedural’ or ‘judgemental’. A small number have both categories. In this context ‘procedural’ means that pupils are following a procedure with limited opportunity for decision making. The researcher’s recent experience in schools indicates that pupils are working to a tight ‘procedural’ methodology which has become known as ‘formulaic design’ with pupils making few decisions. However, the outcome in grades achieved is good. Informal discussions with teachers indicates that they would welcome the opportunity to break away from this way of working. The term ‘judgemental’ is used to describe learning situations where pupils can, and should be, making decisions as this is an important aspect of A’ level D&T.
The interview schedule was designed with two procedural, three judgemental and one both. These are shown in Table 4. The aspects selected can be put into the categories of *procedural* or *judgemental* as shown in Table 4.

'Producing a quality product' has a dual category as this requires both judgements about the meaning of quality and that correct procedures are followed to achieve quality.

The interview process consisted of a discussion about each aspect followed by an agreed grading of level of understanding on a scale: shallow – some understanding – good understanding – well detailed understanding. Additionally, comments to illuminate the response were recorded.

**Participant Observation in School**

The purpose of observation in school was for the researcher to experience, at first hand, the working practices adopted by students as they worked through an AS/A2 level project to further explore the student learning experiences at AS/A2 level. Wiersma (2000:249) considers that observation of this type is: ‘…quite unstructured. Field notes should be synthesised and summarized immediately after the observation.’

In this instance the observer worked with the teacher advising and helping students, who were made aware that the researcher’s presence was part of a study into ‘A’ level work. Pupils’ comments included in this paper are from formative assessment sessions and all were asked if their comment could be used. All responded positively. In this situation Wiersma uses the term ‘privileged observer’. The students were observed whilst working on the module AS level *Product Study: Analysis and Development* which includes an element to design, manufacture and use a piece of test equipment to test materials or parts of a particular product. The focus of this group’s work was material used in packaging, particularly artefacts such as wine bottle carriers, take home pizza boxes, shoe boxes and sports equipment packages. Data was collected in the form of field notes.

**Teacher questionnaire**

The focus of the questionnaire was to establish teachers’ priorities when assessing AS/A2 project work. These would then be considered to establish how well they fitted the examination specification criteria for the A2 modules *Designing and Making* and *Evaluating*. The researcher accepted that examination board specifications vary but they all include these aspects of D&T.

Wiersma (2000:75-176) considers that low response rates to questionnaires can introduce an element of bias to the data and the possible effects of this need to be considered when developing a research strategy. He considers that:

> individuals will respond to questionnaires if the perceived cost of responding (in terms of time and effort) is low relative to the perceived reward.

He quotes Dillman’s advice (1978), that one of the perceived rewards for a respondent is ‘…being consulted on an issue of importance to the respondent.’ (Dillman in Wiersma,2000:76)

In the light of this the researcher developed a survey type questionnaire with the title ‘Less than a minute of your time’. This asked teachers to:

> ‘…please write in the space below a maximum of six key words and/or phrases which spring to mind when you consider how you prioritise when assessing a

| **Developing a design specification** | procedural |
| **Communication and visualisation** | procedural |
| **Selection of materials** | judgemental |
| **Selection of manufacturing processes** | judgemental |
| **Working creatively** | judgemental |
| **Producing a quality product** | judgemental/procedural |

*Table 4: Classification of questions within the interview schedule*
project produced by a Y13 student of A2 Design and Technology. By project I mean the whole; both the design work and the practical outcome. It is your spontaneous response I am interested in so please do this now.’

Stamped addressed envelopes were provided for the reply.

Results and discussion

Interviews

Interviews started with a discussion about the project the student had chosen. In most cases they brought the artefact they had designed and made, or photographs of it. Following a short discussion about each aspect the interviewees graded themselves on the four point scale.

‘Design specifications’ are covered at several points in the examination specification therefore it is not surprising that the majority of interviewees had a good or excellent understanding. Similar results were obtained for ‘communication’ and ‘visualisation’ as these feature in several of the modules. Interviewees spoke confidently about these aspects.

However, the data for ‘selection of materials’ indicates (Chart 3) that the interviewees had far less understanding of both the physical properties of materials and their working properties. Two interviewees commented that they had little opportunity to select materials as they were given ‘what was in the store room’. Three other interviewees said that the ‘technician gave out the material so they did not really have much choice.’ One student, who rated him/herself as having good understanding commented that if ‘they hadn’t got what I wanted I went to B&Q or somewhere like that’. ‘Knowledge and understanding of materials’ is included in the modules Product design 1 and Product design 2 and extensive work is done in the module Product study: design and development.

The researcher experienced a similar lack of knowledge about materials and processes during the school observation, with several students not knowing the difference between types of manufactured board such as plywood, chipboard and MDF. This lack of understanding extended into metals as several could not identify sheet steel or aluminium alloy and they had little understanding of the properties. The majority did not know how to select wood screws and appropriate drills to use when assembling their testing equipment. It seems this had not been covered in their previous D&T GCSE course. A further possible reason for this lack of basic knowledge is that the group had a mix of GCSE qualifications which included graphic products, systems and control as well as resistant materials. Additionally some had transferred from other schools for their post-16 work making it difficult to know the extent of their D&T capability.
A similar result occurs in the interview data represented in Chart 4 where the majority of interviewees had shallow or some understanding of ‘selecting manufacturing processes’. Again this is confirmed by the experiences of working with AS students in school when they were designing and making their testing equipment. All students needed considerable help in establishing ways their designs could be assembled. They had to be given guidance on relatively simple joining processes such as selecting appropriate wood screws or nut and bolt fixtures, knowing how to select pilot and clearance drills and making mechanical joints in manufactured boards prior to using adhesives.

The question about working creatively prompted in-depth discussion about the meaning of creativity within D&T and whether people were ‘just naturally creative’ or whether it is possible to ‘teach people to be creative’. Six students considered they had a good or excellent understanding of working creatively, but they could not identify how they attained this. The majority (17) claimed some or shallow understanding; however 13 of these students claimed they had not experienced any teaching about creativity or discussed creativity during their A’ level course.

Some understanding dominates the result (Chart 6) for ‘Producing a quality product’. Interviewees commented that their teachers had repeatedly reminded them of the importance of working to high standards and they understood the importance of ‘making things properly’. There was some discussion about the differences in difficulty of using various materials, with comments such as ‘I stuck to what I like working in’ and ‘the technician helped me do the difficult bits’. More interesting, however, are the comments such as ‘I didn’t have time to do it properly’, ‘I had to learn how to do it on my major project – I should have had a go on some scrap metal first’ and ‘my teacher talked about the quality of finish but really I needed to know how to make it better’. Interviewees with a good or excellent understanding were more clear about the importance of ‘planning work’ and being prepared to ‘do it again if it’s not right’. Four of this group had hobbies with a making element such as making models and four admitted that parental advice over a number of years was to ‘do it properly’. Interestingly, three of this group had a D&T teacher as a parent.

The researcher’s experience in school was that students did not see the importance of making their test equipment to a good standard as ‘it’s just for testing stuff’ and ‘it’ll be OK – as long as it works’. Machines manufactured by six students required substantial
teacher intervention to ensure that they were constructed to a standard appropriate for use. Most students did the testing carefully recording the results and taking photographs of both their machines and the outcomes of their tests. The majority of reports (for examinations purposes) were of a good standard with three excellent examples. These consisted of well written notes with photographs, scanned sketches, tables and charts embedded in the text. Students followed a formula recommended by the teacher for both the content and layout of their reports. One student commented 'I should have made it better so it would look good in my report.' and another's 'it works OK but it's a bit scruffy'. The researcher’s conclusion was that this group did not have a sense of the need to produce good quality practical work but they did consider it important to produce a good quality report.

return slips which indicated their support for the topic of the research, for example:

- 'About time we looked at the assessment'
- 'I'm sure we've got the assessment wrong for some of the modules.'
- 'A' level is now fragmented and there isn't enough time for making projects.'

The analysis of the questionnaires consisted of recording words and phrases in similarity groups, for example words and phrases such as ingenuity, creativity, innovation, inspirational design and originality were recorded in the same group and the word occurring most frequently was then adopted as the heading for that group. In this case innovation was the dominant word. A group was identified as other for words and phrases which were not easily grouped. Some were useful indicators of teachers’ thinking, examples being the 'wow factor, X factor, what the moderator will think' and 'hitting the right buttons'. While others were more procedural and less useful, such as ‘must include photographs, bullet points in text’ and 'level above GCSE'.

Chart 7 shows the result of the analysis. The most popular six words/phrases (set 1 above 20 responses) being innovation, quality, manufacturing skills, communication, design process and research and development. The second set of words (set 2 between 5 and 20 responses) is significantly less popular numerically and include 'fitness for purpose, evaluation, complexity, examination criteria, use of technology and organisation'. A response of less than 5 was not allocated to a set because of small numbers.

'Less than a minute of your time' - teacher questionnaire
Seventy five 'Less than a minute of your time' letters were issued to schools, selected randomly in England. Fifty seven were returned, giving an excellent response rate of 76%. However, two respondents had not recruited D&T AS/A2 students therefore 55 returns were used as data. It is reasonable, therefore, to assume that teachers considered the issue as 'important' and the response was 'low cost' in terms of time (Wiersma, 2000:175176). Nine teachers added comments to their
These words have been further categorised using the ‘procedural or ‘judgemental’ notation described previously. Table 5 shows the result.

<table>
<thead>
<tr>
<th>Word or phrase</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set 1</strong></td>
<td></td>
</tr>
<tr>
<td>innovation</td>
<td>judgemental</td>
</tr>
<tr>
<td>quality</td>
<td>judgemental</td>
</tr>
<tr>
<td>manufacturing skills</td>
<td>procedural</td>
</tr>
<tr>
<td>communication</td>
<td>procedural</td>
</tr>
<tr>
<td>design process</td>
<td>procedural</td>
</tr>
<tr>
<td>research and development</td>
<td>procedural</td>
</tr>
<tr>
<td><strong>Set 2</strong></td>
<td></td>
</tr>
<tr>
<td>fitness for purpose</td>
<td>judgemental</td>
</tr>
<tr>
<td>evaluation</td>
<td>judgemental/procedural</td>
</tr>
<tr>
<td>complexity</td>
<td>judgemental</td>
</tr>
<tr>
<td>exam. board criteria</td>
<td>procedural</td>
</tr>
<tr>
<td>use of technology</td>
<td>procedural</td>
</tr>
<tr>
<td>organisation</td>
<td>procedural</td>
</tr>
</tbody>
</table>

Using this evidence Set 1 seems to indicate that teachers see innovation and quality, both judgemental, as key criteria for assessment at A’ level yet and they then seem to focus on procedural criteria. Set 2 with, considerably less significance, is similar. Words related to knowledge and understanding do not feature in the list although use of technology and manufacturing skills could be seen as requiring knowledge and understanding.

**Conclusions**

A’ level D&T continues to grow in popularity in England and recent reviews of specifications have both improved the modular structure and addressed issues concerned with consistency in presenting the knowledge and understanding within the specification. These reviews have also resulted in refinement of the assessment criteria.

The AS/A2 specifications provide good opportunity for students to develop the range of learned capabilities identified by Gagne. Three of the modules analysed provide opportunities for students to develop at least three of the capabilities and a further two allow for
development of two aspects of capability. The OCR specification is typical with the AS module *Product Study: Analysis and Development* addressing four learned capabilities and the A2 level *Designing* module addressing all five. However, evidence from this research shows that modularisation may have resulted in fragmentation of the learning experience for students as they may not be making linkages between the more theoretical modules assessed by written examination and the designing and making activities of other modules. It is possible that this is one reason why the higher grades are not being attained by more students.

Both the interviews and the researcher’s experience of working with AS level students show that procedural aspects of D&T are being developed to a good standard. In contrast, the judgmentally focused application of knowledge and understanding does not seem to receive similar prominence. Procedural criteria dominate the teachers’ list of words obtained by the ‘Less than a minute of your time’ questionnaire. There is an anomaly here, with the top two criteria of *innovation* and *quality* being classed as judgemental. However, evidence from the student interviews indicates that the teaching does not give adequate support to develop these judgemental qualities of innovation and quality.

The specification does include marking criteria which refer to both *innovation* and *quality* (and associated words), but these do not stand out as prominent criteria. The conclusion is that teachers think *innovation* and *quality* are important but are not necessarily providing teaching and learning situations which develop these attributes. The evidence suggests that teachers are working strictly to the specification but would like to broaden the scope of their work. To facilitate this it would be helpful to teachers if the examination specifications are reviewed to give *innovation* and *quality* greater prominence both in the content of modules and assessment criteria.

Gagne does not include *innovation* and associated attributes in his five learned capabilities so it may be that these are difficult to teach. This was the view of a significant number of interviewees. *Quality* is important to teachers but for reasons indicated by student interviewees, such as a lack of time for practical work and difficulty establishing teaching and learning strategies, interviewees accepted that they had difficultly achieving this attribute. *Quality* in the communication aspects of D&T is good and is seen to be important by both teachers and students. The evidence of this research shows that there is a need to elevate *quality* in practical work to the same level as that for communication.

Finally, it seems that teachers, the examination specification, assessment criteria and the learning experience favour assessment of procedural criteria, although it is clear from this research that teachers are sending the message that judgemental criteria are top of their list of priorities. Review of AS/A2 criteria is currently underway by the Qualifications and Curriculum Authority (QCA). When this is completed examination boards would be well advised to consider that when developing their specifications they pay particular attention to the overall student learning experience and teachers’ views of assessment at this level. Doing this is likely to enable D&T at this level to continue to prosper.

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