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Effective student industrial designers: identifying formative factors

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Introduction
Experience teaching industrial design at an undergraduate level has shown the author that students with a high grade ‘A’ level in Design subjects from schools do not, necessarily, succeed at a high level at university. There are clearly many factors involved and the relationships will be both complex and unique to individuals. This paper presents work done to start unpicking these factors and relationships.

The aim was to explore formative factors in developing excellence in students’ industrial design capability prior to university. The method used was to interview a sample of the highest performing first year industrial design students at Loughborough University. In parallel a small group of staff conducted a reflective analysis on the approaches to design which students in the cohort as a whole brought with them on entry. Factors emerging from these sources are then juxtaposed with some of the literature and discussed with the intention of identifying areas for further research which could inform the teaching of design at a secondary schools level.

Key limitations are that the approach of using eight high performing students means that the findings may not transfer to a ‘normal’ population, or, indeed, a different sample of high achievers. We need to be aware that the students were identified as ‘high achievers’ on the basis of achievement in the first semester design practice module rather than the industrial design course as a whole. In addition it is acknowledged that the objectives of design in secondary education are broader than feeding undergraduate design courses.

Background
This section explores some of the relevant literature that deals with the growth of a child's design ability from the early pre-school years through primary and secondary education.

Baynes (1996) explores children’s early encounters with design in pre-school years. He re-visits much of the psychology and sociology of childhood and relates it to the type of play activity that is a precursor to design activity. He concludes that children need both suitable resources for designerly play and support from relevant adults in valuing that play.
The Ofsted (2005a) subject report for primary level (ages 5 – 11) design and technology reports that ‘pupil achievement in design and technology compared unfavourably with almost all other subjects’. In addition the report notes that there is a growing trend to marginalize the time available for design and technology. Other factors in this under achievement were the relative lack of design and technological subject knowledge in primary teachers, together with classrooms ill-suited to such activities. The report states that teachers tend to focus on the intended outcome of activity rather than planning for the development of ideas in pupils. Clearly failure to nurture design and technology capability at a primary level will have a direct impact on secondary level work.

At a secondary level The Design and Technology Strategy Group (Barlex 2003. p4) expressed the aspiration that ‘the real products of design and technology education are empowered youngsters, capable of taking projects from inception to delivery…….’. However the group acknowledge that they have concerns about levels of creativity, innovation and problem solving displayed in coursework. They state that, especially at ages 11-14, teachers often lack experience in design and technology, which translates into fewer opportunities for children to develop their natural curiosity.

Ofsted (2005b) report that standards of attainment in public examinations in design and technology are rising as provision improves, but can we be clear on such a causative relationship? We might hypothesise that teachers are getting better at ‘teaching to the test’ and, additionally, question whether the ‘tests’ (i.e. GCSE and ‘A’ levels) are providing a sound basis for the development of excellence in design and technology when pupils enter universities.

Ofsted (2005b) report that secondary teachers of design and technology have a generally good command of the subject. This, however, contrasts with Barlex (2003), above, at foundation level (11-14), and can be juxtaposed with work by Hopper and Downie (1998) which indicates that teachers tend to focus on the artefact being designed by children and that teachers give little thought to the strategic skills that should be developed, even though the same teachers in this research reported that they valued such skills. This is a similar finding to that of Ofsted at a primary level (above). Hopper and Downie quote work by Saxton and Miller (1996) ‘many of the concepts that lie close to the heart of design are not understood by our colleagues’ (Hopper and Downie 1998 p58). The work of Atkinson (1994) supports the above. She noted that projects are the main teaching method for design and technology but that the National Curriculum for Design and Technology (1999), plus the examination syllabuses at GCSE and ‘A’ level tend to interpret design processes involved in an often ‘narrow, unhelpful and restrictive manner’ (p 30). She argues for a more informed and flexible approach to teaching design projects, which can accommodate the unique nature of each child’s work. She notes that over-guidance can dampen creativity. This author, on the basis of regular contact with schools, recognises these issues but would also link them to previous points on teachers with limited subject expertise and confidence who tend to approach design in a simplistic, formulaic manner; often following structures
they see in public examination syllabi. It is a process which, superficially, looks straightforward; the production of a designed outcome, yet the processes involved in learning to design effectively are highly complex and dynamic.

Method
This paper reports an opening phase of what is intended to grow into a broader enquiry. The research approach adopted is aimed to be flexible and inclusive in an attempt to identify factors which can be refined and quantified in subsequent work. Three sources have been used to date: literature, a sample of eight high performing first year undergraduate industrial design students and a reflective analysis of feedback from academic staff involved with the first year cohort of undergraduates this sample was drawn from.

The sample was chosen for high performance on the design practice module in semester one of the course. Performance in other modules was not considered; yet the design work completed was inclusive in nature requiring a good understanding of human factors, technology, materials science and design. As such it was the closest approximation to student's prior experience in GCSE and 'A' level project work.

The students were interviewed individually using a semi-structured technique (Cohen et al 2003). The central question was “consider factors which inspired you in becoming a good designer from your earliest memories up until entry to university”. This open – ended question was supported by supplementary questions specific to pre-school, primary and secondary education phases. Data was recorded using a ‘mind-map’ approach (Buzan 1982) with the author and interviewee able to pen points on an A3 sheet. Each mind-map was then used to generate a factor/time line of points raised. These could be clarified by subsequent email contact. The individual factor/time lines were then compared and it was possible to identify areas of commonality.

The three staff working with the first year cohort in semester one for design practice were asked to reflect on their interaction with the cohort and identify issues they saw as arising from design approaches and experience the students brought with then at the start of their university studies. Whilst these observations are based on a small number of staff it does represent a very considerable experience of undergraduate teaching of about 45 staff/years. The design background of the staff ranged from the aesthetic to the technical and included experience teaching in schools and as an ‘A’ level examiner. Two of the staff regularly interviewed students applying for undergraduate industrial design courses.

The data generated from the reflective process was, again, qualitative. The author identified the central factors and issues emerging. Finally the literature, student data and staff data could be juxtaposed.

Results
Student interviews
Each of the interviewees was clear that the roots of their design ability and motivation lay in the pre-school years. They confirm Baynes’ (1996) findings. All had parents and close relatives who were supportive of their exploration in 2D and 3D form. Parents supplied a range of materials which enabled designerly play, notably some means of making marks (crayons etc) and some form of 3D modelling method. All noted that parents did not ‘teach’ them to draw, but supported them in mark making with verbal encouragement and took an interest in what their child was doing.

All interviewees reported being given Lego and could remember its use as one of their earliest recollections, usually between the ages of two and four. All saw their experience using this modelling system as critical to their subsequent interest and ability in design. They observed that the system gave structured models as start points but that they were quickly adapting such models in their own way. All stated that by the age of 4 or 5 they were using this modelling systems, plus others, relatively freely to develop their own forms. The interviewees reported that colour, speed of build, flexibility, tactile qualities and movement were important factors in attracting them to use these systems. It was noted that most of the sample had moved onto more sophisticated ‘technical’ versions of these systems by the time they started primary school.

A common theme was early exposure to children’s television programmes such as ‘Art Attack’. These programmes were watched at a pre-school age and were reported to be inspirational. In some cases a relative was a ‘practical person’ who allowed the child access to a workshop and encouraged them to use materials.

On entering primary school several interviewees noted the advantage they gained from their prior experience with 2 and 3D modelling. They noted staff did not teach them to draw or paint, but did reward good work with praise. Memories of 3D design at a primary level were much less strong. All remembered some form of craft but often the design element was minimal. When a 3D design project was remembered it involved movement or a competition.

At secondary level all interviewees reported their relationship with their design and technology teachers to be different to that with other staff. Typically they report teachers who were enthusiastic, positive and easily approachable. These teachers managed a learning environment that was more flexible; pupils were able to talk and move about. Some interviewees reported that their teachers showed examples of their own work and also other, professional, designers.

Several interviewees reported being motivated by the workshop and studio environments in their secondary schools. This contrasted with the necessarily more general, flexible, nature of primary school rooms and facilities. Equipment, displayed projects and, to some extent posters all contributed to making the design and technology department an interesting place to be for these interviewees.
All interviewees reported that having a degree of freedom was an essential motivating factor in design. They reported much of the work they did at secondary level up to GCSE to be uninspiring, often because teachers were ‘trying to get basic skills over’. It was only their own motivation from their preschool experience that maintained their performance in design and technology. In some cases the work up to and including GCSE was highly craft orientated with little focus on integrating technology or product design. The interviewees reported that most had experienced linear approaches to design at GCSE and teachers who only focussed on 'the project' and even then only in terms of basic form.

Whilst the interviewees reported that the GCSE years (14-16) offered them more freedom to design they noted that teachers again promoted a very rigid structure. Teachers stated that it was examination boards that required this structure. Interviewees reported frustration at this approach. Nevertheless all interviewees reported high levels of motivation in their major projects at both GCSE and 'A' level. Having a degree of freedom was seen as motivational.

The strongest and most commonly reported motivational factor at secondary level was extra curricular work based in the Design and Technology facility. Particularly strongly impacting these pupils were competitions such as 'robot wars' and remote control car building and racing. The interviews showed that such activities far outweighed normal lessons for motivating these pupils. Note that these activities were run by the same teachers who taught design and technology in a manner reported as often bland and uninteresting.

Several interviewees reported informal group work, particularly at A2 level, to be motivational. In each case this was simply the day-to-day discussion within an informal design environment.

Interviewees reported a growing interest in the possibility of design as a career from early secondary onward. They reported that no teachers promoted such a career, neither did schools careers advisors. Nevertheless interviewees reported that teachers were subsequently central to their choice of specific university once they embarked on the application process.

Staff reflection
Staff reflection was based on experience with undergraduates and applicants as a whole, rather than just the high achievers. It showed a mismatch between the apparent objectives and approaches to design at schools and university levels. Most schools appeared to promote an approach that centred on the production of a 'folio'. This folio followed strict conventions and became a 'product' in itself; work was done which was quite unnecessary to the process of developing a design. Examples include ornate boarders and the use of colour on virtually every drawing; almost a form of 'colouring in'. Teachers are not promoting efficient and effective design. Many applicants report that they put in a great deal of extra time into their design work, but that they 'enjoyed taking their time' over a drawing. A significant amount of university teaching time had to be spent helping students to realise that such
approaches cannot be used in a professional environment and, indeed, can lead to ineffective design. Linked to the above is a poor ability to manage time and project once in a university environment. Students report that a very formulaic approach is used in schools. This provides a structure for students but does not enable them to learn how to manage a project when staff do not impose such a structure.

Staff noted that students tend to arrive with one 'sketch style' and use this style for all aspects of design work from initial concept to detailing. They tend not to appreciate the need to use looser styles at early phases and to explore a concept and develop more precision as ideas are resolved.

Initial concept work is typically interpreted as meaning the drawing of a number of amorphous and unrelated shapes. There is rarely a logical exploration of concepts based on human factors and function. These initial concept drawings tend to be over-worked with superficial detailing which can detract from effective concept selection. Such over detailing also slows down what should be a fast and fluid phase of design.

Students had experience of 3D modelling as a part of a design process, but teachers had failed to get across the concept that 3D, as with 2D modelling, should be used to advance a design and not simply to report a final concept.

Students on entry generally have relatively little understanding of detailing of both external and internal form. For many pupils design appears to stop with a general form.

In contrast to the above the development of CAD skills in schools has been a success story with pupils able to produce ever more sophisticated form. Features in these CAD programmes also enable far more accurate and flexible exploration of colour and texture.

Discussion
A number of areas of interest are evident. The observations on pre-school experience involving parents who supply kits and drawing equipment reinforces existing understanding (Baynes 1996) and will not be discussed here.

At a primary level it is apparent that most teachers are not able to provide design or technology experiences which motivate the type of student in this sample. This may link with the Ofsted (2005a) observation on the unfavourable achievement of pupils in design and technology against other subjects at a primary level. Whilst the link between motivation and achievement is not fully understood it is apparent that the weight of professional experience is that without motivation achievement will fall. The interviews showed that, with this sample, motivation increased when teachers enabled some degree of freedom to design, whilst maintaining a framework for the project, and that the designed device involved some form of movement. This observation also holds at an early secondary level where, while the design and technology teaching and learning environment may have
be stimulating to our sample, in some schools the actual work undertaken can be bland and uninteresting. We must ask ourselves whether some pupils become de-motivated by this teaching approach.

At a secondary level, increasing freedom gave the sample students more interest, but teachers were adopting very formulaic approaches to design, encouraged by examination board requirements (Atkinson 1994, Hopper and Downie 1998). University staff reflection shows the experience of interviewing students with misguided folios in which the presentation of the folio, page by page, appears to be more important than the actual process of advancing the design being worked on.

Is interesting to contrast Barlex’s (2003) aspirations for design and technology as ‘empowering youngsters capable of taking projects from inception to delivery’ with actual practice as indicated above. Note the tight structure to GCSE and ‘A’ level project work/folios is failing to enable pupils to manage projects when they move beyond that structure. Note, also, Atkinson’s (1994) warning of how such tight structures can dampen creativity. The author notes that the National Curriculum is not, in itself, a source for this restrictive approach to teaching design and technology. The problem appears to be the ways in which teachers and examination boards have interpreted it and structured their syllabi.

In contrast to the above note how pupil motivation (in this sample) rose when design and technology teachers were enabled to work in their own way, outside the restrictions of examination syllabi. Here teachers have organized clubs and competitions based on design and technology which motivates many pupils. Further work will be needed to identify the degree to which elements of such competitions motivate such pupils. Was it the element of movement in the design or the competitive nature of the activity? Competition has been used positively in teaching design and technology (Denton 1993) but teachers who employ it need to understand the limitations as well as advantages. It is certainly an area that merits re-visitation in terms of research in design and technology education. These ‘special clubs’ or events also indicate, again, the apparent special relationship between design teachers and pupils involving communication and enthusiasm.

**Conclusion**

The strongest design students, as represented by this sample, appear to have a deep motivation which started to emerge at an early age, certainly pre-school. Their school experiences appear to have had relatively little impact on them in relation to design and technology. Indeed one student was so frustrated in the way that design and technology was taught to him that he reported that ‘teachers tested my patience’. These students have succeeded in design and technology in schools which, in some cases, provided a very bland experience. At the root of the problem appears to be an approach to teaching the subject which is formulaic, over-structured and rigid. It is not motivating brighter students and this may also be the case with the broader ability range. This is an issue which has been raised before (Denton 1993b),
we need to become far more thoughtful in the way we teach design and technology.

These results are based on a small, but representative sample. Further work is intended which will look at a broader sample of students’ experiences of the teaching and learning of design and technology in UK schools with regard to the development of effectiveness in design. At this point conclusions must be tentative, nevertheless there are clear indications that:

- It is essential that pre-school children are given opportunities to engage in the type of activities which underpin design capability; that is basic drawing and constructional activities. These activities must offer frameworks for success but enable individuals to explore.
- The type of teaching and learning regimes established by some design and technology teachers (possibly many) in UK schools is not inspiring pupils. The indications are that it is teachers’ perceptions of the National Curriculum and examination board requirements which has developed a rigid and uninspiring design and technology experience for their pupils.
- Once design and technology teachers feel they are free of National Curriculum and examination board requirements they have developed inspiring and effective teaching and learning experiences.

References


