

DESIGN EDUCATION: HOW DESIGN IN TECHNOLOGY EDUCATION DIFFERS FROM DESIGN IN INDUSTRY

Michael Parker

**School of Education, University of Waikato
Student, Graduate Diploma Teaching (Secondary)**

John Lockley

**School of Education, University of Waikato
Lecturer, Mathematics, Science and technology Education Department**

Abstract

We are surrounded by examples of things that have been designed, the clothes we wear, the cars we drive, the towns we live in. Design can be seen everywhere and is an integral part of the very human need to create and be creative, and can be seen as a creative problem solving process.. This desire has been a part of our makeup since ancient humans first picked up a stick and designed a use for it. As humans we are all continuously designing our environment from what we are going to wear today to what to have for dinner. However design and creativity are looked upon as a mystical gift bestowed upon a selected few, even though the ability to be creative, design and problem solve is to be human. This skill comes naturally to all of us. Technology in the New Zealand Curriculum became mandatory for all schools in February 1999 (Jones, 2003). This essential learning area is now being taught in Primary Schools right through to Bursary level. This has seen the development of a number of different models and ways of teaching design and design processes in order to help teachers assess and teach design in Technology classrooms. There is however an increasing literature and evidence about the shortcomings of the use of step by step models of design and how they can even hamper the learning of design and students' creativity. Despite this growing evidence in the literature there is still a strong presence of a systematic "one size fits all" model of how design should be presented in schools. This paper investigates how design is presented in schools and compares the designing practices of professionals in their fields with design by students.

Introduction

Design and creativity are not easily defined, because of their unseen character. The activity of design is something we all partake in with varying amounts of skill but have little understanding of how we do it. It is a universal human characteristic (Court, 1998). However design itself is a relatively recent concept. Design and the making of things, up until very recently, have been inextricably entwined. Before the Industrial Revolution, an artisan was both designer and maker simultaneously with no distinction between the two (Mitcham, 2001, p. 30) (Heath, Heath, & Aage Lund, 2000). Working not from drawings, plans or detailed design briefs artisans and craftsmen have for thousands of years produced sophisticated and beautifully designed artefacts using

tradition and patterns handed down from generation to generation. Changes were incremental and happened over many years. Since then, mainly due to the Industrial Revolution and mass production, the making and designing of things have become separated. The separation between designer and maker is now a cornerstone of our industrialised society so much so that the increasing speed of technological advances and the side effects of this are seeing an ever increasing need for designers (Lawson, 2008, p. 21) (Mitcham, 2001).

The challenge for designers is to create something new and original that did not exist before. Designing is the process of working out the solutions to problems with the expectation that the solution is original and creative. The ability to do this relies on the designer working simultaneously at many different levels and making a number of decisions as they design. Designers are using technical, procedural and conceptual knowledge in varying amounts simultaneously when solving a design problem. The creative activity of design and problem solving is an extremely complex cognitive process.

Design education in secondary schools

The traditional focus on Technology Education has been on the activity of doing and making. With this process students learnt a limited amount of technical and procedural knowledge such as manipulative skills, tool use and safety, for example (Williams, 2000). This has changed due to research which has shown an intimate connection between knowing and doing: How action affects doing and doing affects action. This has seen changes in Technology Education to take advantage of the doing as a vehicle for deeper learning. This has led to project based learning and is the key strategy for teaching and learning in the domain of Technology. Vygotsky (1987) brought our attention to the importance of introducing everyday activities into the classroom and the importance of the social context in learning and how this develops the formation of concepts within children. Technology, unlike other subjects, is not a body of knowledge but an activity. In addition, by situating the activities in a real social context the subject of Technology is ideally suited to teach students meaningful concepts. Therefore, by students participating in technological activity they do not just learn, they learn to become something (McCormick, 2004) (Fleer, 2008).

The design process and problem solving are seen as an essential part of Technology Education as without design there is no technological outcome. There is now a lot of focus on design and the teaching of solving problems as it is shown that it is within this realm of knowledge that real learning for students occur. The power of this type of learning is in its ability to be authentic with the real world. Students become motivated and enthusiastic as they become involved with a project that is relevant and personal to them (Turnbull, 2002). Boucharen (2006) puts forward the argument that the experience and curiosity of the students can do more to improve design education than the teaching of theoretical content. Technology Education is different from other domains as there is no body of knowledge to learn and remember, the students

themselves become the designers of their own body of knowledge and this allows them to take ownership of it and motivates individuals to take responsibility for their own learning.

Design education is now seen as an important part of Technology Education (McCormick, 2004) (Ministry of Education, 2007), but despite their being clear evidence of the complex nature of design, design education continues to rely on simplistic models that try to replicate the design process (Johnsey, 1995) (Lawson, 2008) (Middleton, 2005) (Barlex & Trebell, 2008). Design is commonly taught to students at secondary level using a design process. The process is usually communicated in a graphic form with some schools using acronyms such as 'PRISMA' Problem, Research, Investigate, Solution, Make, and Analyze (Clark, 2008).

Due to the increased focus on design and problem solving in Technology there have been a number of models produced and used to teach design and problem solving with Johnsey (1995, p. 202) identifying seventeen different versions in schools across England and Wales. The literature suggests that the use of these models forces students to conform to a particular process which they are told they can apply to all design problems. This view however is in opposition to how designers in industry actually work and interestingly how students themselves work. The literature suggests that students will follow the processes taught to meet assessment and teacher expectations but will actually carry out the process in their own way.

Despite the growing evidence against the effectiveness of teaching design via a systematic process, that can be used in all problem solving activities, there seems to be a consensus in the way design is taught in schools. A common presentation includes,;

- A problem or need is identified
- A brief is given that covers important specifications
- Research is undertaken
- Individuals sketch their concepts (usually a set number)
- The best concept is chosen
- Using drawings, individuals show development of thinking from concepts through to a final idea
- Final idea is presented
- Final drawings which consist of instrumental drawings are done
- The final idea is made
- The prototype is Tested

The stages described above are seen in the model shown in Figure 1 which was taken from a New Zealand decile 8 all boys school. The model in Figure 1 shows that at each of the stages in the design process there is an allowance made for modifications and changes to overcome any problems that might arise. The model shown is mirrored in most New Zealand Schools.

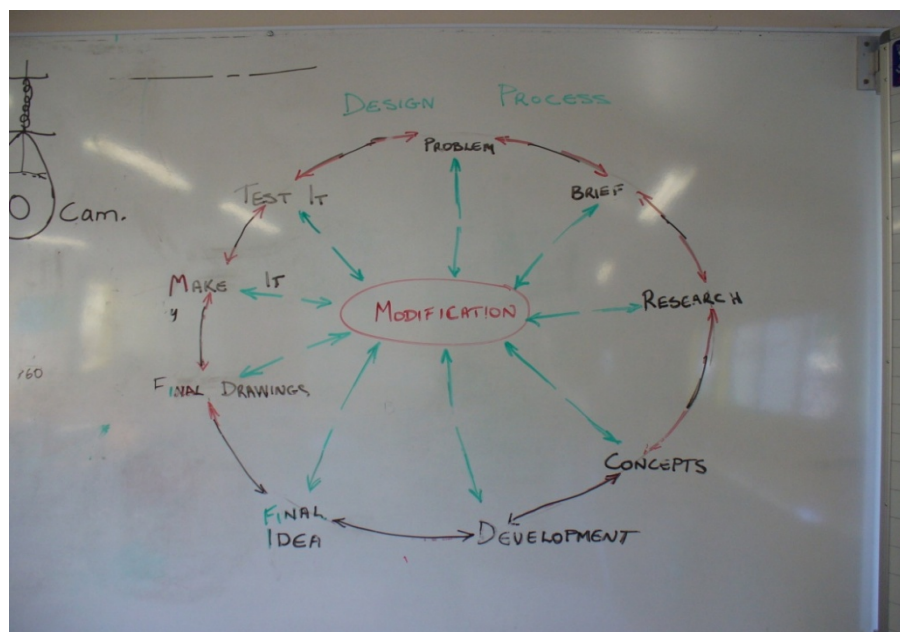


Figure 1

Using a model in technology, as in any other area, is prescriptive. It assumes that there is a definite starting point, and by working through the steps will lead to a precise and correct solution. There is also the assumption that the solution lies within the strategies presented in the model. This format works very well in the domains of science and maths. However in design problems tend not to have precise starting and finishing points and require the creation of different strategies to solve them which come from the students' social background, prior knowledge and information they have gathered around the problem (Middleton, 2005) (Lawson, 2008) (McCormick, 2004).

Although the model in Figure 1 is shown as circular and appears to be iterative in that modification is a part of all processes. Nevertheless this is very rarely the way the process is taught. McCormick (2004) points out that teachers often treat design as a series of steps and methodically work through them; presenting and thinking about a problem, clarifying it, thinking of alternative solutions, implementing and then evaluating. This leads to what he calls a ritual which has little affect on students thinking. This is an important point as the design process and problem solving are deemed important in Technology to improve students' conceptual and procedural knowledge, not just to teach them skills. (McCormick, 2004, p. 26) (Middleton, 2005, p. 62) (Ewington, 2002). Additionally, Mawson describes the design processes used in schools as a helpful guide but observed that such models had an equal amount of danger involved in using them due to the prescribed stages that need to be done. This then has

the effect of turning design into a series of end products (Mawson, 2003, p. 119). Thus this is the danger in using any type of model as it is only capable of showing a series of outcomes rather than the process it is meant to illustrate.

The question then arises about how important is it for Design Education to use processes that are authentic with the real world. Williams argues that if the goal in Technology Education is to turn out technologists at all levels from engineers to trades people then the practices used in teaching should be derived from what is practiced in the discipline. However if the goal is more general and schools are developing a more technologically literate citizenry then it would be reasonable to obtain the teaching practice from learning theory (Williams, 2000). Nevertheless, there is agreement that students only become competent in designing through experiencing the design process as an authentic problem solving activity (Christiaans & Venselaar, 2005) (Turnbull, 2002) (McCormick, 2004).

Turnbull (2002) argues for the importance of authenticity in Technology Education. The most important feature in any Technology classroom is that the activities are authentic and have a connection with the real world. An activity can be said to be authentic if it is personally meaningful and purposeful within a social framework. The implications of this in the teaching of Design are that learning happens when it becomes a meaningful activity within the student's physical and social world. The activities of design and problem solving should involve real solutions from real materials (Middleton, 2005). Therefore it is important for the teaching of design and design activities to be authentic with the practices of how people design elsewhere. Furthermore the teaching has to be authentic. 'Teachers need to act like technologists in their classrooms. They need to solve unfamiliar problems for students and not be afraid to make errors or have difficulties finding solutions. By serving as a role model, Technology Teachers can show students how to collect and use information to solve technological problems and help them realise that not all problems have straightforward and simple solutions' (Johnson, 1992, p. 34). However Turnbull (2002) points out that a high percentage of teachers in the field of Design and Technology have no training in the knowledge and skills of technological practice in any form and this can explain the reliance on models to teach design. Furthermore Wilson and Harris (2003) also point out the importance of teachers modelling professional practices, and how teachers that do not model professional behaviour can impede their students' creativity.

Design in industry

Design is a complex metacognitive activity which relies on an intimate relationship within the domain of knowledge in which the designer is working as well as knowledge about design itself (Middleton, 2005). Designers very often need to be skilled at divergent thinking and then have the ability to converge that thinking down to one of an infinite number of solutions that take into account aesthetics, societal and environmental issues. As Lawson points out this is no easy task and designers often do not understand the source of their creativity.

There are as many different types of designers in the world as there are industries, however most come under the following groupings.

The artisan or craftsman designer, who has a history as old as humanity itself. These designers, although diminishing in numbers since the industrial revolution, are still around because the way they work is the most natural and obvious form of design. They design and then make, usually specialising in a related group of materials.

The industrial designer designs practical products and systems. They are trained to express their ideas using drawings, modelling and building prototypes. Their main considerations are ease of use, aesthetics, quality and economy of manufacture of the product. The industrial designer has to have a thorough knowledge of and close relationship with the manufacturing process and their designs should reflect this relationship.

The architect designer is one most individuals are familiar with and have an opinion about. A large proportion of design is architecture, as most individuals live and work in buildings that have been designed. Architecture not only has to be aesthetically pleasing it also has to be functional, relate well to the end users and fit into its environment.

Mechanical engineers have designed some of society's most impressive artefacts, such as bridges and prime movers. Their process of design can be seen as quite mechanical such as calculating the size of a beam that has to span a required distance and withstand a certain loading. However there is still an expectation of creativity within this field (Court, 1998).

The fifth group is the artist designer, this group includes fashion design and marketing. This group of designers rely on and usually have the freedom for a lot more creativity than those mentioned previously. Their knowledge of what is required is quite often vague. Their products are usually designed to gain attention and prestige and develop a reputation for the design company (Heath, Heath, & Aage Lund, 2000)

Design is becoming more and more complex, and as such collaboration between designers is becoming more important. In the professional world design is more often a group activity with different designers given roles relative to their speciality and strengths. This is very rarely seen in schools where the need for individual assessment drives the need for individual work (Mawson, 2003). Thus an important part of designing is the ability to work in groups. Designers also have to collaborate with different professions such as market analysts, psychologists and manufacturing engineers. Vary rarely is design an individual process (Lawson, 2008).

Clearly there is a large range of designers from the very structured world of mechanical design right through to the freedom of fashion design. Lawson points out that if each of the groups were given the same design problem there would be five different solutions each related to the domain from which the designer resides. Furthermore within these

domains they all have their own specialised languages which are used to communicate ideas and perhaps design pathways. There is however one common element to all of them and that is they all require considerable technological knowledge and the ability to be creative.

Student Designers

The literature suggests that students naturally design in ways that are very similar to how professionals design. McCormick (2004) discusses how in a design activity the students use a language and gestures that represent the problem and possible solutions and are very personal to the students and problem. The language is developed around the problem to describe and understand what is happening. Lawson points out the very similar process that professional designer's use when working in a group environment and how the language develops around the problem and gesturing is used when language fails to explain. In addition Anning (1997) points out that young children instinctively use drawing in the same way that professional designers do to explore and converse with themselves when generating ideas. Students are naturally creative and have an innate ability to design and problem solve. Thus when students are faced with a model on how to design that is inauthentic with what they know to be right they design in their own way and then mechanically follow the model to appease the teacher (McCormick, 2004) (Mawson, 2003) (Williams, 2000). Johnsey (1995, p. 213) argues that none of the models he describes in his research are based on observations of students working in a wide range of design situations and contexts.

The individual steps that are involved in the design models which are used in teaching design have raised questions amongst researchers about how well they represent design. Although most researchers agree that there are a series of processes professional designers go through these processes can be very different due to personality, background or area they are working in. The first problem becomes the problem itself as in a classroom environment there is a shortage of real clients with real problems. Therefore the student, school or their immediate family become the clients. In the area of Graphics the design problem is usually set by the teacher or Department in relation to meeting the standards of assessment. The problem and brief are set in such a way that students are able to meet the standard of assessment. The problem is accompanied with a brief which is most often unchangeable as this is also used as part of the assessment process. The students' outcome is then checked to see if it meets the initial brief. In Materials Technology the problem and brief are more flexible and are changed as more information is obtained. This is more in relation to what happens in industry. Ewington points out that in industry designs, drawings and specifications are rarely final. This is so common an occurrence, especially in architecture, that there are usually contractual agreements that allow changes to be made (Ewington, 2002, p. 5). Additionally a brief emerges from an ongoing relationship between the constraints and considerations and everything someone does changes your idea of what is possible. One cannot start with a brief and then design; they are both developed simultaneously as both activities are completely interrelated (Lawson, 2008, p. 47).

Another stage in the process that is problematic is student research. Students are required to research other people's solutions to the problem, different materials and joining processes, research into user groups and so forth. Gaining information gives you expertise in the area in which your problem resides and an important part of being able to solve the problem. However in reality it is difficult to know what information is needed until some of the other stages are attempted. In addition, students see this as a step with a start and finish. However research is an ongoing activity right through the whole design process. Additionally problems start to arise as to how much information is enough with students using the easier process of information gathering to put off the harder work of coming up with ideas and solutions. This can be seen in students' portfolios with information that has little or no relevance to the problem or solution. This procrastination rarely happens in industry due to budgets, time constraints and pressure from clients (Lawson, 2008).

One of the paradoxes of creative design, is that in order to think originally, we must familiarise ourselves with the ideas of others. These ideas can then form a springboard from which the creator's ideas can be launched. Mawson states that less attention should be given to design models and more done to develop students' design skills and technological practice. Before a problem can be solved students need to be given time to immerse themselves in the context of the task. The literature also points out the importance of domain knowledge as essential for creative success (Mawson, 2003) (Nicholl & McLean, 2008) (Lawson, 2008).

Another consideration is the development of a culture of creativity in the classroom where mistakes can be seen as opportunities and students feel safe in taking risks. The literature suggests that to enable this teachers need to authentically model creative, problem solving behaviour and act like technologists (Rutland & Barlex, 2008) (Mawson, 2003) (Lewis, 2005) (Turnbull, 2002). Furthermore the literature points to the importance of authenticity in design and creativity with the tasks needing to be relevant to the students so that they take ownership and take control of their learning. Inauthentic practice can happen due to teacher inexperience and the drive to meet assessment demands (Turnbull, 2002) (Nicholl & McLean, 2008).

Conclusion

This paper argues that the use of a model, whether it is linear, circular or iterative, in the teaching and learning of design is not effective. Despite this being known for some time a systematic approach in design pedagogy has persisted. The design process used in schools is removed from how professional designers work and how the students themselves work when given the opportunity to design. Professional designers and students work in an organic way which allows and fosters creativity. A codified approach to design does more to hamper creativity than inspire it.

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