Malcolm Welch

Malcolm Welch is an associate professor in the Faculty of Education at Queen's University, Ontario. He teaches graduate courses in research methods and curriculum design and undergraduate courses in teaching methods and design & technology. He has directed several research projects and has published widely in academic journals. Currently, he is principal investigator on a three-year research study that is investigating how pupils learn to make design decisions. He has worked on major curriculum projects in England and Canada and has co-authored eight textbooks.

The pupil as designer

Malcolm Welch

Introduction

Michael Shannon (1990) wrote that, *'design is a subject with profound cultural implications that needs to be addressed by public education…Designing the world we live in is everyone's opportunity and responsibility [and]…design must become a basic attitude about living that shapes every person's priorities'* (p. 29).

Q. What is your response to Shannon's contention that designing is a part of culture? Does everyone have an opportunity to contribute to the made world? If yes, what are those opportunities? In what ways would the made world be different if every citizen took responsibility, to some degree, for its design? How will you address these questions with your pupils?

This chapter, which has four parts, is about teaching pupils to design. Part 1, subtitled "**Is teaching pupils to design important?**", provides a rationale for design education as an essential element in the education of all pupils, both elementary and secondary. Part 2, "**Teaching pupils to design**", will (a) describe the types of tasks you can use to teach pupils to design, (b) describe a pedagogy that supports pupils as they learn to design, and (c) list five interrelated abilities pupils must acquire in order to develop capability as a designer. In Part 3 of the chapter, you will be introduced to a model, developed by David Barlex, that describes the types of interrelated design decisions that pupils must learn to make. Part 4 provides an overview of ideation techniques and modelling skills pupils will need if they are to generate, develop, communicate and evaluate design ideas. The chapter ends with suggestions for further reading and a list of references.

Is teaching pupils to design important?

More than twenty years ago, in 1982, Nigel Cross laid the foundations of a rationale to support the inclusion of design as a mandatory component of general education for all pupils. This rationale contained three important ideas.

First, design develops the innate abilities of the pupil to solve a particular type of real-world problem. C. West Churchman (1967) described these problems as ill-defined or *'wicked'*. Wicked problems are those that, unlike the well-structured problems tackled in mathematics,

01 Everything we use has been designed.
05 (Photograph 01 © Claudia Christen for Smart Design.)
06 Nigel Cross.

07 Richard Kimbell.
08 David Perry.

are individual (each is unique), have no definite formation (understanding and describing the problem is the designer's first step), do not contain all the necessary information for their resolution, are not susceptible to exhaustive analysis, have no stopping rules (designing can continue without time limits), and have no one correct solution. One aim of design education is, therefore, to allow the pupil to develop the ability to understand the nature of ill-defined problems, how to tackle them and how they differ from other types of problem.

Second, design supports constructive thinking. This is quite distinct from the inductive and deductive reasoning common to the sciences and humanities. Jerome Bruner claimed that constructive thinking sustains the pupils' cognitive development in their ability to manipulate images in the mind's eye.

Third, design offers opportunities for the pupil to develop a wide range of abilities in nonverbal thought and communication. While the humanities and sciences rely on verbal, numerical and literary modes of thinking, design thinking relies on a range of modelling techniques that can be used to externalise ideas that develop in what Eugene Ferguson (1992) referred to as *'the mind's eye'*. These non-verbal modelling techniques include various forms of graphic images (sketches, drawings and diagrams) as well as three-dimensional models. Models serve as an aid to internal thinking as well as aids to communicating ideas to self and to others.

In 2001 Richard Kimbell and David Perry published a very important paper entitled "**Design and technology in a knowledge economy**". This paper describes the *'distinctive contribution which design and technology makes to the school curriculum'* (p. 1).

According to the authors, this distinctive contribution:

- Engages pupils in a task-centred activity (taking a project from inception to completion within the constraints of time, cost and resources);
- Requires pupils to tackle increasingly wicked tasks;
- Requires pupils to unpack the wickedness of a task and also acknowledge that design is not just about change but about improvement, which is value laden;
- Engages pupils in creative exploration, to conceive and plan what does not yet exist, to operate in a world of uncertainty and risk;
- Engages pupils in modelling ideas, an iterative process in which the pupil moves back and forth between models in the mind's eye and models in reality;
- Manages the complexities and uncertainties arising from tackling wicked problems;
- Leads to increasingly autonomous learners capable of taking responsibility for their decisions and living with their consequences (pp. 5-7).

The pupil as designer Malcolm Welch

How would you describe the concept of capability in the context of design education? What would you say to a parent who asked you to justify design education as part of his or her child's education?

Teaching pupils to design

Now that you have a rationale to support design education for all pupils, you will need to think about answering three questions:
(a) What types of tasks will encourage and promote learning to design?
(b) What pedagogy will effectively enable this learning? and
(c) What design skills must pupils acquire in order to be successful? The remaining sections of this chapter respond to these questions.

Setting appropriate tasks

Patricia Murphy and Sarah Hennessy (2001) have described the nature of tasks that teach pupils to design to a high standard. These authors refer to such tasks as *'authentic tasks'*. The next section of this chapter explores two aspects of authenticity: *personal authenticity* and *cultural authenticity*. While they are interrelated, they can be thought of distinctly.

A design and make activity that has *personal authenticity* requires the pupil to identify a need and is orientated towards clients and markets that he or she can relate to. Pupils will be involved in the context of the problem (e.g., helping a bed-ridden person avoid becoming bored). This leads to both the design and make activity and the tasks within to have personal meaning and relevance for the pupil. The pupil must also be given the opportunity to make significant decisions: decisions that allow him or her to be creative (e.g., identify the user, specify the product, propose a solution; not simply make relatively trivial decisions about colour or aesthetic elements of the shape). Being in control and having autonomy, including making a range of design decisions, are all part of what creates personal authenticity in pupils' learning experiences.

In addition to exploring the context of the problem, Patricia Murphy and Sarah Hennessy suggest that pupils need to see the context for its solution. *Culturally authentic* design and make activities relate to activity in the world outside school - in this case in the community of practice of technologists. This implies saying who the pupil is in the process (e.g., part of a company that produces wooden products), and the relationship to any client (e.g., the sibling or friend of a bed-ridden person). *Culturally authentic* design and make activities are sophisticated and 'real' (e.g., a system to detect whether an old person has fallen over and summon help).

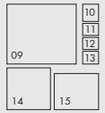
? Identify some authentic design tasks for a Year 10 pupil living in a flat in a high-rise building. Now identify some design tasks that would not be authentic for this same pupil.

Pedagogy to promote learning to design

David Barlex (1995) has described a robust pedagogy that supports pupils as they learn to design using authentic tasks. This pedagogy has, at its centre, a *'capability task'*.

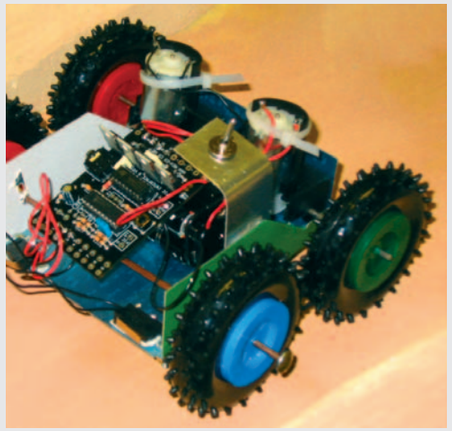
A capability task is a significant activity in which pupils have to use the knowledge, understanding and skill they have been taught in an integrated and holistic way. It forms a focal point in a teaching sequence and enables pupils to reveal what they have learned through what they can do. A capability task requires pupils to intervene in, and make improvements to, the made world by designing something that they themselves can make and then making the product they have designed. Both the product and the processes by which the product is conceived, developed and realized are significant in this activity.

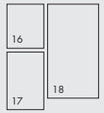
For pupils to be successful in a capability task they will need particular and appropriate knowledge, skill and understanding. These are taught through a series of *'resource tasks'*: short, highly structured and focused activities through which the pupil acquires the knowledge, skill and understanding he or she will need to successfully complete a capability task. Resource tasks are active. They require pupils to engage with design skills, technical



09 - 15 What sort of design tasks leading to products like these will be both personally and culturally authentic for pupils?

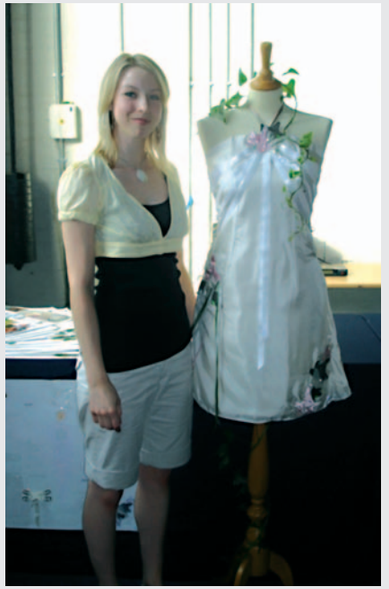
(Photographs 9, 10, 11, 12, 13 & 15 © The D&T Association.)





16 - 18 What sort of design tasks leading to products like these will be both personally and culturally authentic for pupils?

(Photograph 16 © The D&T Association.)



understanding and making skills.
While a single resource task will usually address a quite narrow topic, a sequence of such tasks will lead to a pupil acquiring a wide repertoire of design, technical, constructional and aesthetic knowledge and skill. The effectiveness of this teaching and learning is evidenced through the quality of response to the capability task.

For example, in a capability task entitled "**Desk Lamp**", pupils are given a design brief in which they are to design and make a desk lamp with a light source that is focused and fully adjustable for height and angle and with an on/off switch. To be successful with this design and make activity pupils must be able to generate, develop and communicate ideas; mark, cut and shape sheet materials to a high degree of accuracy; use electric components to build a circuit; use mechanical components to achieve adjustability; and assemble parts. Once a desk lamp has been designed and made the pupil must evaluate the product and his or her own learning.

Hence *before* responding to this design brief (design and make a desk lamp) pupils will complete the following resource tasks:
- Exploring existing products;
- Using a collage to generate ideas;
- Exploring simple, series and parallel circuits;
- Exploring reflective materials;
- Exploring mechanisms;
- Writing a design specification.

?

List the three major points that you find intriguing or interesting about using *'resource tasks'* and *'capability tasks'* as a pedagogy for teaching and learning in design & technology.
In what ways is this pedagogy different from what you experienced as a pupil?
What challenges do you see for you, the teacher, when implementing this pedagogy?
What challenges do you anticipate pupils will have when engaging with this pedagogy?

What must the pupil designer learn to do?
Teaching pupils to design in the formal setting of the classroom is very demanding. Although they will have been 'making stuff' from an early age, this will have been largely spontaneous, needs-driven, have used three-dimensional materials and have been completed in a non-structured environment. However, be warned! Pupils frequently don't respond enthusiastically to the often ritualized designing required by teachers in the design & technology classroom. According to Bob McCormick and Marion Davidson, (1996) the ritualisation of designing has become a significant problem in design & technology education. The Office for Standards in Education noted in its 2000 annual report that attainment in design & technology education is often limited because students spend too much time on superficial work associated with the presentation of their portfolios at the expense of the main core of designing and making activities.

If a pupil is to develop his or her capability as a designer, he or she must acquire a set of five interrelated abilities:
1. How to make design decisions;
2. How to generate design ideas;
3. How to develop design ideas;
4. How to communicate design ideas;
5. How to evaluate design ideas.

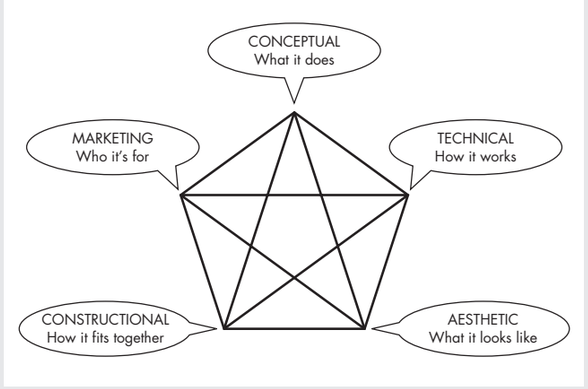
Reading through this list might suggest that designing a product is a linear, algorithmic process. But no designer proceeds in a straight-line path from the first step (describing a context) to the final step (evaluating the design proposal). Nigel Cross (2000) describes how designing is an iterative process that is heuristic rather than algorithmic, one that uses *'previous experience, general guidelines and rules of thumb that lead in what the designer hopes to be the right direction, but with no absolute guarantee of success'* (p. 29).

The next section of this chapter describes the types of design decisions pupils will engage with in your classes, and will exemplify and discuss ways to enable your pupils to generate ideas. This is followed by an overview of the modelling techniques that pupils may use to develop, communicate and evaluate design ideas. But before doing any of this, a small detour is in order.

A small detour!
Before we examine the skills you will have to teach pupils if they are to become increasingly competent as young designers, it is worth thinking about the prior knowledge of designing that pupils bring with them to your classroom. Prior knowledge is comprised of a pupil's images, reminiscences, experiences and intuitions that are lodged in the subconscious - what Michael Polanyi (1966) refers to as *'implicit knowledge'*. In the past, an assumption has been that the pupil arrives at the design class with little or no relevant prior knowledge, what Lev Vygotsy refers to as *'spontaneous concepts'* (Vygotsky, 1934/1986, p. 146). But recent research that I have conducted with David Barlex and Erin O'Donnell (2006) indicates that this may not be the case.

In Year 1 of a three-year study, Year 6 pupils were asked questions about the skills needed by a designer and what designers need to know in order to design particular products. Analysis of the data has revealed that students,

The pupil as designer Malcolm Welch



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19 The design decision pentagon.
(© D. Barlex, 2007.)

who had no previous experience of design & technology education, demonstrated a considerable knowledge of not only what designers do, what skills they need to have and their personal characteristics, but also substantial knowledge of what designers need to know in order to design a range of products. It appears as though elementary students' beliefs about designers and what designers do provide a significant fund of knowledge relevant to learning to design.

These findings should not be surprising, for a constructivist view of learning argues that pupils do not arrive at any classroom empty-headed, with a *tabula rasa*. Rather, they arrive with lots of strongly-formed ideas about how the world works (Brown, Collins and Duguid, 1989). Effective teachers have always recognized the need to begin instruction *'where the pupil is'* (Ausubel, Novak and Hanesian, 1978). For meaningful learning to occur, new knowledge must be related by the learner to relevant existing concepts in that learner's cognitive structure.

?

Speculate on the experiences relevant to learning to design that your pupils may have had.
What might you be able to do to help your pupils use what they already know about designing?

Discuss your suggestions with colleagues and work out how you might build this into your practice.

Learning to make design decisions

You read earlier in this chapter that a designer is required to make design decisions that span elaborating the overall concept to resolving the small particulars. David Barlex (2005) has suggested that in the context of school-based designing, pupils should be given the opportunity to learn to make five types of interrelated design decisions:

(a) Conceptual;
(b) Marketing;
(c) Technical;
(d) Aesthetic;
(e) Constructional.

Conceptual decisions are concerned with the overall purpose of the design, that is, what sort of product it will be. Marketing decisions are concerned with, for example, who the design is for, where it will be used and where it will be sold. Technical decisions are concerned with how the design will work. Aesthetic decisions are concerned with what the design will look like. Constructional decisions are concerned with how the design will be put together.

This can be represented visually, as shown above, with each type of decision at a corner of a pentagon and each corner connected to every other corner.

This inter-connectedness is an important feature of making design decisions. A change of decision within one area will affect some if not all of the design decisions made within the others. For example, a change in the way a design is to work will almost certainly affect what the design looks like and how it is constructed. It may also have far-reaching effects in changing some of the purposes that the design can meet and who might be able to use it.

Donald Schön (1987) describes designing as a series of *'What if I did this'* moves. Hence, we can envisage a pupil making a series of such moves as he or she considers possible decisions about a feature and its effects on decisions made or yet to be made about other features. Kees Dorst and Judith Dijkhuis (1995) describe designing as a reflective conversation with the situation in which the inter-connectedness of the decision-making can be seen as the pupil constructs his or her understanding of the emerging design proposal through a constructivist reflection-in-action paradigm. Donald Schön and Grant Wiggins (1992) suggest that the use of *'What if I did this'* moves is more than a mere *ad hoc* tool to cope with the complexity of designing. Its repeated use also increases the pupil designer's understanding of the issues, thereby informing, guiding and stimulating further designing both within and outside the given design situation. Siang Kok Sim and Alex Duffy (2004) consider these iterations as a powerful tool that the designer uses to learn about the design proposal as he or she is creating it.

Design skills for the pupil designer

As you read earlier in the chapter, if a pupil is to become an increasingly capable designer then he or she must develop the ability to:
(a) make design decisions;
(b) generate ideas;
(c) develop ideas;
(d) communicate ideas, and
(e) evaluate ideas.
The next section of this chapter describes the types of design decisions pupils will engage with in your classes, and will exemplify and discuss ways to enable your pupils to generate ideas. This is followed by an overview of the modelling techniques that pupils may use to develop, communicate and evaluate design ideas.

Generating ideas

Where do 'good' ideas come from? When you have a 'wicked' design problem to solve, what knowledge and resources do you draw from? Chances are that you do several things, including:

- Visit a store and look at existing products similar to the one you plan to design;
- Leaf through books and magazines to gather ideas;
- Think about other similar products you have designed;
- Talk to family and friends about your problem;

20 Pupils examining products.

"Existing objects are a form of knowledge about how to satisfy certain requirements, about how to perform certain tasks"
(Cross, 1982, p. 225).

- Sit quietly and think, doodle and sketch ideas;
- Draw upon your tacit knowledge about a wide range of areas, including the made world, design skills and technical knowledge.

? What strategies do you use to help pupils learn from existing objects? How will you bring the knowledge embedded in objects to pupils' attention so that they can learn from it?

There is an ancient Chinese proverb that states *'On a blank sheet of paper the most beautiful of marks can be made'*. While this may be a helpful idea for you or for a professional designer, it will not be helpful to most of the pupils you teach, who are novice designers. A blank sheet of paper will be very intimidating to many pupils. So you must teach strategies that will enable your pupils to produce (generate) a lot of ideas quickly.

There are a number of well-developed idea generation methods available to help pupils think more creatively. Methods range from logical, structured problem-solving procedures to those that are intended to encourage lateral thinking. Some of the techniques you can use with your pupils are listed below:

- **Brainstorming** is a technique for a group of people to generate a lot of ideas quickly;
- **Attribute analysis** is a technique to produce new designs from familiar objects;
- **Bubble charts** are a technique for recording answers to the questions: What? Where? When? Who? and Why?;
- **Observational drawing** is a technique that uses detailed drawings of an object (natural or made) to generate new design ideas;
- **Making connections** is a technique for connecting different ideas in a new way.

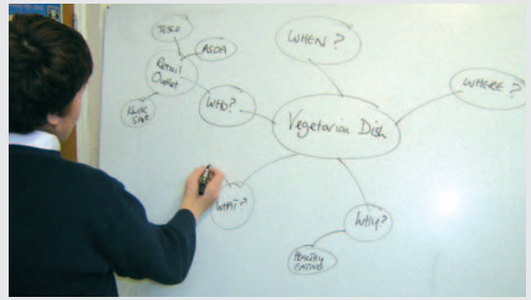
? Discuss with colleagues the ways they encourage pupils to generate ideas. In what ways are these different from the strategies you use with pupils?

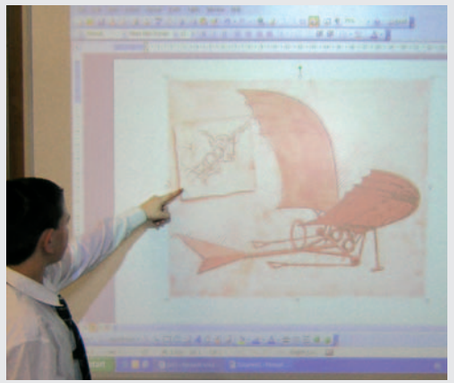
Using sketchbooks with pupils

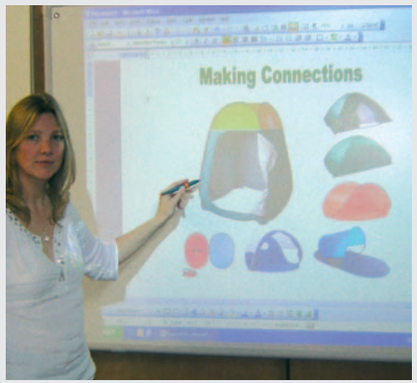
Another powerful aide for pupils learning to generate design ideas is a designer's sketchbook. According to Gillian Robinson (1995) *'a sketchbook is an Aladdin's cave of visual ideas…a personal visual memory bank that can be used as a resource for…developing ideas'* (p. 14). Robinson advocates that pupils should be encouraged to keep a sketchbook so as to function as researchers. Andy Ash and colleagues (2000) describe how the use of a sketchbook can help pupils *'to develop self-awareness and skills as independent learners and critical observers'* (p. 193).

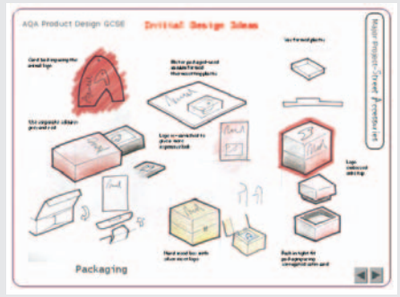
Pupils could be encouraged to acquire the 'sketchbook habit' early in their design & technology career and be taught to develop their sketchbooks in increasingly diverse and personalized ways as they mature and their confidence and skills grow. The sketchbook could be used for information gathering as a pupil searches for a creative solution to a design problem. According to Ash et al. (2000) this will encourage the development of a personal response, develop investigation skills, encourage critical and analytical skills, develop self-awareness as an independent learner, promote an active and creative approach to learning and help pupils develop documentation skills. A pupil's natural curiosity, enthusiasm and need for personal realization and expression will be reflected in his or her sketchbook as a personal vision.

21 - 25 Simple techniques for generating ideas.









26 Sketching is
- an important
28 skill.

(Photographs 26 & 28 © The D&T Association.)

Malcolm Welch and David Barlex (2003) have written a set of introductory guidelines and activities that provide support for teachers wanting to use a sketchbook approach to enhance their own creativity as well as introduce sketchbooks to pupils.

Would using sketchbooks with pupils lead to increasingly creative responses to 'wicked' design problems? What strategies would you use to encourage pupils to maintain a sketchbook? Could a sketchbook carry over between key stages?

Developing, communicating and evaluating design ideas

Ideas in the 'mind's eye' (cognitive models) are tenuous - they can be forgotten easily and it is difficult to clarify them. The pupil designer needs to externalise these cognitive models so that they can be developed, communicated and evaluated. To do this the pupil can use various forms of modelling, which Bruce Archer (1979) has referred to as the *'essential language of design'* (p. 133). These include:

1. Sketching and drawing (two-dimensional [2D] modelling);
2. Making models from paper, card, other easy-to-use materials, and simple components (three-dimensional [3D] modelling);
3. Using symbols (circuit diagrams and mathematical models);
4. Using computer aided drafting (CAD) and other software (spreadsheets and illustration packages).

Using two-dimensional modelling to support designing

Christopher Tipping (1983) considers it essential for pupils to be taught to sketch: *'Fluent sketching ability may be the single most important factor in developing any general design ability'* (p. 45). There can be little doubt about how useful sketching, defined as making lines freehand, is as a form of thinking. Various authors have identified how sketching serves the designer in four important ways.

First, sketching allows and encourages the designer to 'play' with ideas, an essential stage to creative idea development. Sketching is a powerful tool for formalizing, exploring and testing playful musings, to explore and manipulate the unknown.

Second, sketching helps the designer explicate needs, define and clarify the task. Sketching is a crucial part of the process of understanding and gaining insight into a design problem. Edward Robbins (1997) argues that *'until you delineate [a] design conception in a drawing you really cannot claim to understand it'* (p. 32). Renzo Piano, the international architect, claims that *'it is a mistake to believe that now I understand the problem and now I draw it. Rather, right at the time you draw you realize what the problem is'* (quoted in Robbins, 1997, p. 27).

Third, as Edward Robbins (1997) has written, sketching is essential for communicating ideas, both with 'self' and others. In your classroom, a pupil designer's sketches will evidence to you, the teacher, what he or she is thinking. Sketching enables you, the teacher, and other pupils to reply rapidly and fluently to a pupil's sketches and contribute to his or her thinking.

Fourth, sketching facilitates the evaluation of a design proposal and the identification and restating of problems. Sketching provides a means of testing concepts, which in turn will encourage the further generation of ideas. As Stephen Temple (1994) wrote, evaluation permits progression *'from an innovative mental image to a vehicle for analysis and criticism'* (p. 24).

But the assertions made by the authors quoted above were written in the context of professional design practice. Hence, as teachers, we must ask to what extent a reliance on sketching helps or hinders the pupil designer.

What skills will you need to teach pupils if they are to become more fluent at sketching? What opportunities will you create for pupils to use 2D modelling to explore design ideas? What do you see as opportunities and challenges for you, the teacher, in requiring pupils to develop and communicate ideas using sketches?

Using three-dimensional modelling to support designing

According to Donald Schön (1987), *'designing is a creative activity. A designer's reflective conversation with the materials of a situation can yield new discoveries, meanings and inventions'* (p. 161). But when Donald Schön wrote these words, he was referring to the professional designer. So as teachers we must ask the question: Can pupils engage in a *'reflective conversation with materials'*?

The bulk of a pupil's untutored designing skill will have been acquired in the material world: building sand castles, using commercial construction kits, or constructing using found materials.

Research by this author (Welch, 1999) identified the critical role of modelling in three-dimensional materials as an aid to pupils' thinking. Modelling was used to support a range of activities:

- Increasing understanding of the problem;
- Stimulating the generation of solutions;
- Seeing what a design would look like;

The pupil as designer Malcolm Welch

- Testing, and continuously incorporating modifications and improvements into a solution.

What skills will you need to teach pupils if they are to become adept at using 3D modelling to develop, communicate and evaluate design ideas? What modelling materials will you introduce to pupils? What opportunities will you create for pupils to use 3D modelling to explore design ideas?

What do you see as opportunities and challenges for you, the teacher, in requiring pupils to develop, communicate and evaluate design ideas using 3D models?

What does the phrase *'a reflective conversation with the materials'* signify to you?

Using symbolic modelling to support designing

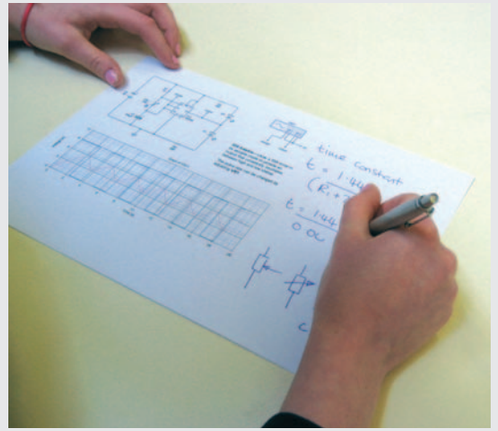
Symbolic modelling uses symbols to represent objects, the physical properties of objects,

29 - 30

29 3D modelling. - 30

31 - 32

31 Symbollic - modelling. 32



33 34

33 Modelling - on screen.
34 (Photographs © The D&T Association.)

and the relationships between them.
For example, pupils may use mathematical formulae to calculate the size of a resistor needed in a circuit. They may collect data and create a bar chart to illustrate the nutritional value of various foods. They may create graphs to show the relationship between the cross section of a beam and its rigidity. They may draw circuit diagrams to show the connections between electrical components. For particular forms of symbolic modelling, for example circuit diagrams, there are usually conventional symbols. But sometimes pupils can make up their own symbols as they struggle to get to grips with their emerging ideas.

?

What skills will you need to teach pupils if they are to become skilled at using symbolic modelling to develop, communicate and evaluate design ideas?
What opportunities will you create for pupils to use symbolic models?
What do you see as the opportunities and challenges for you, the teacher, in requiring pupils to develop, communicate and evaluate design ideas using symbolic models?

Using computers to support designing
The computer-assisted design (CAD) software available in schools may be used to explore the form of an object, animate a mechanism, explore a variety of finishes, perform calculations concerning performance and generate working drawings. Spreadsheet software can be used to explore the mathematical relationships between features of a product and used to model both technical and economic aspects.

?

What skills will you need to teach pupils if they are to become skilled at using virtual modelling to develop, communicate and evaluate design ideas?
In what ways is virtual modelling more useful and less useful than 2D and 3D modelling?
What do you see as the educational advantages and disadvantages of virtual modelling?

Endnote

I will end this chapter by posing two questions that I believe are central to thinking about teaching pupils to design. For each question, I will suggest some enabling questions; starting points to stimulate your thinking. I also encourage you to discuss your responses to these questions with colleagues.

Question 1:
Is the modelling strategy used by pupils a function of the 'capability task'?
Which form of modelling would be most appropriate for pupils designing and making body adornment, an essentially aesthetic task?
Which form of modelling would be most appropriate for pupils designing and making a self-controlled moving toy, an essentially technical/constructional task? How will you ensure that pupils extend their repertoire of modelling skills and then use those skills appropriate to a particular task?

Question 2:
What is the most appropriate sequence in which to teach modelling strategies?
How does this sequence map onto the age, ability and experience of pupils? Given that most of the modelling techniques can be taught in some form at any age, how should capability tasks be sequenced to support progression in learning to model ideas?
How do we encourage pupils to use different modelling techniques in increasingly sophisticated ways?

The pupil as designer Malcolm Welch

Further reading

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The pupil as designer Malcolm Welch