Are Design and Technology Teachers Able to Meet the Challenges Inherent in the theme for this Conference 'D&T – A Platform for Success'?

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Introduction

This paper has emerged out of my life-long passion for Design and Technology (D&T), which I will refer to as D&T from now on, my on-going research which has informed my practice as a teacher of D&T in England over the past forty-five years, and in particular my practice as a trainer of D&T teachers for the past twenty years.

In this paper I have taken the conference theme and I will discuss the problems I see in meeting the challenge inherent in the conference strapline 'D&T – A platform for Success'. I will not be referring to the subject as a whole but homing in on one aspect that I, and many others (e.g. Barlex & Rutland, 2003; 2004; Baynes, 2009; Nicholl, McLellen & Kotob, 2007; Welch, 2007) consider is very important – the activity of 'designing'.

Firstly using references from relevant literature and my own research I will examine the importance of, and difficulties inherent in designing within D&T. I will consider certain aspects of a teacher's understanding of designing and thereby pupils' understanding of and ability to successfully carry out the activity. I will describe the difference between physical skills and conceptual tools required whilst designing. I will discuss the differences between subject knowledge, pedagogical knowledge and personal subject constructs pertinent to this topic and the timeframe available for the training of teachers of D&T. This will lead me into a discussion concerning research I have undertaken and my conclusions regarding designing, and meeting the challenge of 'D&T – A Platform for Success'.

Designing

Archer and Roberts suggested in 1992 that:
"The design act is one of discovering and elaborating and adapting requirements and provisions to match one another. The problem is obscurity about what the requirements might be, ignorance as to what sorts of provisions might be suitable and uncertainty as to how well the one might fit the other."
(Archer & Roberts, 1992 p.3-4)

Whilst in 2004, Ed Miliband wrote that *"designing is the combination of, and movement between, thought and action and an aspect of D&T that helps to make it distinctive in the curriculum"* (Miliband, 2004). This statement continues to provide a sound educational reason for designing being part of every child's education, whilst within D&T itself designing continues to play a vital role. Without it the subject, as we know it today could not exist. Unfortunately taught poorly it has been shown to taint the view that many pupils have of the subject (Atkinson, 2000a) and regrettably there is considerable evidence from Ofsted (1998, 2000), and others (e.g. Toft, 2007), to suggest that too often designing in schools is not taught as well as it could be.

One of the aims of D&T teachers should be to develop a pupil's understanding of how to design effectively and efficiently, so that they can make functionally appropriate, creative, innovative products that are fit for their purpose. Through an appropriate form of design activity pupils can learn to appreciate the relevance of designing as a significant part of their D&T curriculum, not the unpalatable means to an end, which it is perceived to be by many pupils today (Atkinson, 2000a). The 'end' to which I am referring is the activity of 'making', which is understandably enjoyed by the majority of pupils. In terms of manufacturing a well-crafted product 'measure twice and cut once' says it all. Sadly the complexity of designing is such that it cannot be summarised in as simple a strapline. It is this complexity that has caused various educators over the past 50 years to produce simplified models of the activity for teachers and their pupils to follow.

Pupils should be able to enjoy designing as much as making, and some of them do. Although quite often the reason for their enjoyment is nothing to do with the process of designing itself and more to do with an enjoyment of the individual physical skills they use during that process (Atkinson, 1997). Pupils need to believe that although it can be a challenging learning experience, that if carried out successfully ideas will lead to products which when well made, they will be proud to own. Teachers need to be aware that badly designed products however well made, and whatever new skills have been learnt along the way will be a disappointment. Such outcomes are a frustration to those pupils who were born with, or who have developed tacit design intelligence that enables them to understand what is, or is not, well designed. Unfortunately these very pupils are the ones who easily become bored by the simple step-by-step models they are expected to follow and end up becoming disenchanted with the whole subject. However, at the

opposite end of the spectrum there are many D&T pupils who do require a structure to follow. They need considerable help to understand what they must do, how they must do it and what they should be thinking about in order to achieve the level of designerly thinking that we all say is inherent in our subject.

From my PhD research in the early 1990's I developed a table of the complex integrated nature of the various internal and external key factors that could influence a pupil's designing. I also included the external issues that I believed related to the key factors (see Table 1).

I still believe that all these factors remain a good checklist today.

However, in this paper I am concentrating on the first and last of the external factors that I identified
- The design process used, and
- The teacher's knowledge and understanding of designing

This is not because I believe the others are unimportant, but because I believe that the combination of these two provide the biggest challenge to teachers of D&T. I believe that designing can be broken down into two main sets of knowledge and understanding. It is essential that both sets are explained, thought about and taught, if we are to provide the necessary support and learning required by pupils when they are carrying out the activity. There is a set of easily taught physical skills and there is a set of difficult, intangible concepts and intellectual thinking skills. The first set includes such areas of learning as drawing skills, presentation skills, CAD and CAM skills, researching skills, specification writing skills, 3D modelling skills and even tasks to encourage creativity. In this set there are also the plethora of practical skills concerning appropriate materials, components and processes that need to be understood enough to be used when turning ideas into reality. These are all straightforward to teach, very time consuming, but straight forward. The second set, the intangible designerly thinking aspects, aptly described by Burnette (1993,1999) as seven required modes of creative, critical thinking (intentional, referential, relational, formative, procedural, evaluative and reflective) that enable: information and ideas to be organised, decisions to be made, situations to be improved and knowledge to be gained. These are the aspects that I believe teachers find difficult to provide a simple set of explanatory guidelines for pupils to understand and more importantly, use successfully.

Acquiring new conceptual tools consists of putting a complex series of individual ideas, or unconnected pieces of knowledge together to make sense of them as an

<table>
<tr><th colspan="2">Key Factors</th><th>Issues which relate to the key factors</th></tr>
<tr><td>Internal Factors</td><td>Creative ability
Designing style
Learning style
Appropriate knowledge & understanding
Design capability
Manufacturing capability
Goal orientation
Gender</td><td rowspan="2">Educational changes
Historical perspectives
NC requirements
Examination requirements
Accountability</td></tr>
<tr><td>External Factors</td><td>The design processes used
The skills required to carry out the process
The relationship between the knowledge base taught and the design process used
The delivery programmes devised by the schools & the teaching strategy adopted by the individual teacher
The teacher's motivation
The relationship between teacher and pupil
The balance of time given to the various aspects of the process
The teacher's knowledge and understanding of designing</td></tr>
</table>

Table 1. Taken from 'Identification of some causes of de-motivation amongst key stage 4 pupils studying design and technology' (Atkinson, 1997, p288 fig 7.4)

integrated whole (Antonio, 2009). The point at which the pieces come together as a whole is the point at which our minds have grasped hold of a new conceptual tool (Polanyi, 1958) and it is these conceptual tools which I believe are the crux of the problem for pupils in schools, and for some of their teachers. Especially as many teachers seem to be unaware that such skills have to be developed slowly over time rather than being taught just once, or not at all.

Designing has always been problematic within D&T. The process itself, the procedural knowledge required, the practical skills, the thinking skills, the creative skills and an understanding of the complex relationship between them all, have provided myself and many other researchers with much food for thought (e.g. Kimbell & Stables, 2007; Norman, 2008; Rutland & Spendlove, 2007; Toft, 2007). As early as 1986 the Secondary Examinations Council (SEC, 1986) indicated concern about the rigid design process model that was being used in school design activity, whilst in the early 1990's Archer and Roberts (1992) and many others (e.g. Atkinson, 1993; 1994; Kimbell et al, 1991) referred to the use of rule-based models that failed to help pupils solve design tasks, that however simple the brief appeared to be were in fact often ill-defined and complex. Part of the problem has been that all the models produced over the years have been of necessity a simplification of the real process involved. A simplification that is useful as a set of reminders of what might be involved (SEC, 1986) but unhelpful in explaining the complex, interactive nature of the activity. Hennessey & McCormack provided a pertinent insight into what they called "a veneer of accomplishment" (Hennessy & McCormack, 2002) in which pupils appear to use a process (and hence have apparently learnt it), but in fact may not have understood it. By comparison teachers and pupils have tended to find the knowledge and physical skills required to support design activity straightforward to teach and/or learn.

Although the sheer volume of knowledge and skill required, and whether this should be learnt before or on a needs to know basis, has attracted much attention and debate.

For the past ten years Ofsted reports (1998, 2000) have identified that 'designing skills lag behind making skills'. My own research between 92 and 97 (Atkinson, 1997) and that of Barlex and Rutland in 2003 and 2004 have all suggested that that has consistently been the case since the introduction of D&T into the National Curriculum, and I would suggest, even before then. I believe this is due to a combination of factors. Firstly, the difficulties in teaching pupils the necessary conceptual tools, and yet the need to do so as many pupils without tacit design intelligence are unable to develop an understanding of these tools for themselves. Secondly, the fact that designing was not taught to craft teachers of the subject at the time of the introduction of designing into the curriculum. This has had a knock-on effect over the past twenty years because of the cyclical movement of knowledge from teacher to pupils who then become teachers and lecturers training the next generation of teachers to design. This has inevitably resulted in many teachers in schools today still not displaying a deep understanding of the activity within their teaching. Whilst some (e.g. Atkinson, 1997, 2000a, 2000b; Lewis, 1996; Martin, 2008; Ofsted, 1998, 2000; Rutland, 2001, Zanker, 2005), would suggest this is caused by a lack of teachers with the necessary physical skills required, others would lay the blame at the door of examination boards, citing imposed assessment regimes as a cause of the problem (e.g. Atkinson, 2000a; Barlex, 2007; Kimbell; 1997, 2004, 2006; McLaren, 2007). However, I would suggest that although this may be the case for some teachers, for many others the problems arise more from the lack of a secure understanding of designing and the feeling of security that the examination board models of assessment provides for them. For one can find examples from schools of excellent practice where examination work has not been strait-jacketed by the process undertaken, and where design activity has achieved top grades plus the 'wow' factor that well designed outcomes deserve.

However in recent years this is unfortunately far from the norm. Evidence from my visits to schools, my work as external examiner at a number of different universities, and from applicants who wish to study at my own institution having completed their A level in D&T, would suggest that many pupils are still not encouraged, even at A level, to understand the complexities inherent in the activity, or how they can go about working creatively within an examination structure. Unfortunately, the model of the activity that is used is all too often just a repeat of the simple model used earlier in their secondary education. This is re-enforced by their Grade A at GCSE level leading them and their teachers to believe that pupils must have been taught to design correctly to achieve such a good grade, so a repeat of the same is all that is required at A level. Sadly their beliefs are often supported by 'good' A level grades too. Once at University these students expect that the 'successful' design process used in school will continue to serve its purpose and then they spend at least their first year of study struggling to come to terms with their misconceptions and poor design practice. The more mature undergraduate students who come to train as

teachers of D&T do not necessarily have A level D&T qualifications. They tend to have experience and qualifications appropriate to an industrial setting. These students are inclined to have either limited or no design skills, having been in the school system at a time when they either used the tightly structured simple design model already described or attended school before design activity was carried out at all. Many of them have then spent time in an industrial setting building up practical expertise pertinent to one aspect of D&T with little attention given to developing their understanding of designing as that was often not part of their work experiences.

There are of course students studying to become D&T teachers whose designing activity is excellent and whose skills are such that they will be able to transfer that knowledge into an appropriate form for use when they become teachers. However I do not believe we can be complacent about the group of students that do not fit into this category, either for the sake of the pupils they will teach in the future or the prospect for our subject in the years to come.

Content knowledge, pedagogical knowledge and pedagogical content knowledge

In terms of teaching ones subject, since the mid-1980's there has been a growing body of research into the complex relationship between subject knowledge and pedagogy. Shulman's (1986; 1987) contribution was in identifying the overlap between two aspects of teacher knowledge, 'Content Knowledge' and 'Pedagogical Knowledge'. He named this intersection Pedagogical Content Knowledge, which he explained was the very important interplay between pedagogy and content.

In terms of mapping the teaching of designing onto this model I would suggest that in the cluster of Content Knowledge one is referring to a student's personal conceptual understanding and knowledge of the activity of designing. In the cluster of Pedagogical Knowledge one is referring to what a trainee needs to know about teaching in order to deliver the subject of designing to a class of pupils. In the third cluster, Pedagogical Content Knowledge, one is referring to the changes that the trainee must make to his/her personal knowledge in order to turn it into a form that is appropriate for a specific group of pupils to understand.

In 2004 Banks et al, developed their own model of professional knowledge from a D&T perspective. Based on Shulman's work they referred to a teacher's 'Professional Knowledge' in terms of four rather than three interlinked clusters of knowledge; Subject Knowledge, Pedagogical Knowledge, School Knowledge (which Shulman had called Pedagogical Content Knowledge) and at the centre of the three they added a teacher's Personal Subject Construct. This additional aspect of the model is extremely useful in the context of designing.

For it is my belief that if one does not have a sound in-depth understanding of one's subject knowledge then one cannot develop the relationship that needs to exist between that subject knowledge and school knowledge.

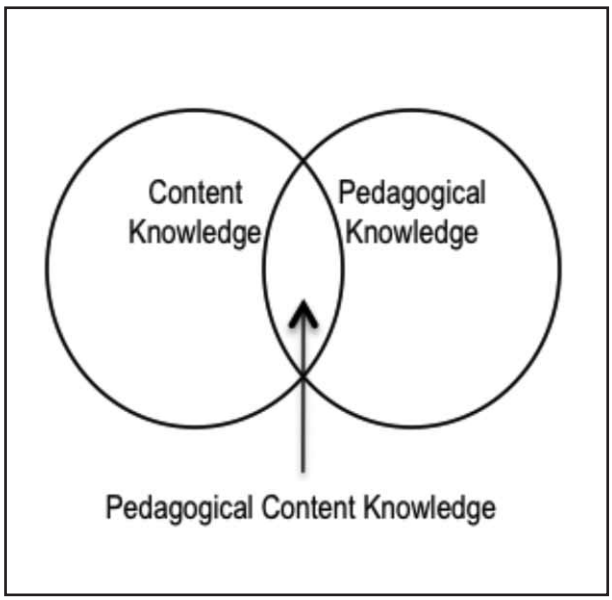

Figure 1. Taken from Shulman (1986) p9

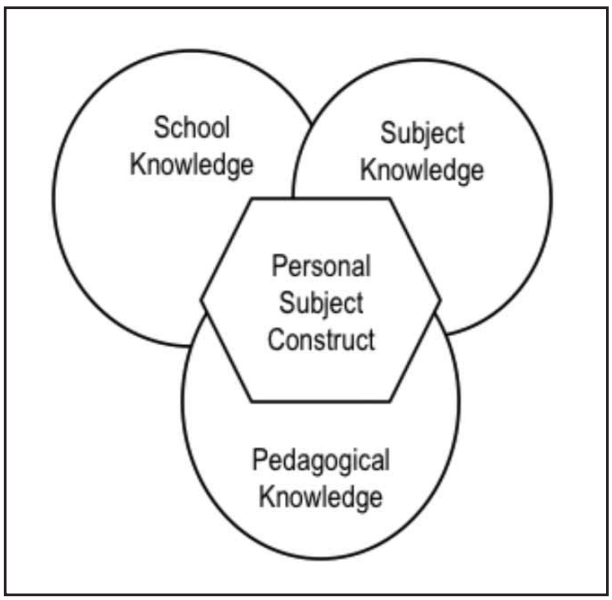

Figure 2. Taken from the CReTE 'teacher knowledge' tool (Banks et al, 2004 p143)

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However I would go one further and suggest that one cannot then develop personal subject constructs to enable one to use powerful strategies such as analogies or metaphors, or develop useful examples, explanations and demonstrations to help explain the subject knowledge to pupils without having a sound grasp of the subject knowledge one is hoping to teach, in this instance – designing. That is not to say that through the development of school knowledge one does not clarify ones understanding of subject knowledge – for even now every time I teach a new cohort of students about designing the interplay between these two aspects continues to change and clarify my understanding of both, along with the new subject constructs that I invent to help explain concepts to them and hopefully develop their understanding.

Training Teachers of D&T

One might assume that being passionate about and thinking about D&T for so long that I would have the answer as to how to train successful D&T teachers. However goal posts continually move, government-led directions change, the student body changes in terms of gender and age balance. The subject quite rightfully moves on, and like designing itself there is no right or wrong solution, no single answer. Also like designing there are so many variables that as one alters/improves or adds in new aspects of the subject, others that seemed fit for purpose interact unfavourably with the new direction, or a pendulum swing occurs which intentionally or unintentionally pushes existing important factors aside and alters the mix – however in terms of the choice between what goes and what stays, at times the saying "throwing babies out with the bathwater" springs to mind.

There are many D&T teachers, who are meeting the challenge indicated in the conference theme. They provide fine examples of D&T teaching at its best. These teachers are passionate about the subject, their lessons are excellent examples of best practice, they keep up to date with new directions, and relish the opportunity to learn about new materials, new processes and new technologies, aspects that make our subject so exciting. Above all these teachers with their ever growing wealth of knowledge and understanding, enable their pupils to become passionate about D&T themselves and gain a rich, inspiring education from all that is so wonderful about our subject. However, I know from visiting schools, training teachers, my own research and reading the research of others, that this picture of the availability of such teachers in schools is often the exception rather than the rule.

In England there has been many government led initiatives to ensure that all newly qualified teachers (NQT's) are trained to the highest possible standard. In terms of pedagogical practice there are the professional standards required for Qualified Teacher Status (QTS) (TDA, 2007a), and in terms of subject knowledge there is the document *'Minimum competences for trainees to teach Design and Technology in secondary schools'* (Design and Technology Association, 2003)

Once NQT's are in post the core standards for main scale teachers at the end of induction (TDA, 2007b), the post-threshold standards (TDA, 2007c), the excellent teacher's standards (TDA, 2007d) and the advanced skills teacher's standards (TDA, 2007e) all provide appropriate progression in terms of 'professional attributes, professional knowledge and understanding, and professional skills' (TDA, 2009) and they are nationally applied. In terms of continuing the development of a teacher's subject knowledge once a trainee is qualified to teach there are no statutory guidelines set in place, implementation is not nationally structured and the development of subject knowledge is only tenuously linked to career progression.

Since the cessation of most local authority control of inset provision and the devolution of funds to individual schools, and more recently the demise of the use of consultants to provide inset (mainly as a result of the new working arrangements in schools which make it difficult for staff to have time out and the added need for staff to produce a portfolio of evidence for career development) the picture of subject knowledge enhancement has become even more haphazard. It is also the case that subject knowledge development that has run successfully has tended to be based around training in new innovative technological processes and materials. Valuable as this training is the limited resources have then not been available for training in other aspects of D&T. Nor has developing subject knowledge been seen as important as it rarely provides credits towards the latest government target – a Master's qualification for all teachers.

In terms of government initiatives that have been available to support subject knowledge enhancement in D&T related areas, these have been in strategically chosen aspects of the curriculum. For instance STEM Partnerships (STEM, 2009) with SETNET and SETPOINT networks aimed at assisting teachers enhance and enrich their knowledge and understanding to meet the STEM curriculum have been set up. In terms of the new 14 – 19 curriculum and the Diplomas that impinge upon our area of the curriculum, free bespoke support through IAG (Information, Advice and Guidance) champions has been put in place. Whilst of even more relevance to this paper

has been the government's Secondary National Strategy for School Improvement (previously called The Key Stage 3 National Strategy). With its re-focus on the teaching of designing skills and developing creative thinking skills (Miliband, 2004) and the development of materials and workshops to help teachers implement the new D&T Framework. However, even this strategy seems to have lost impetus with many of the materials produced gathering dust on bookshelves, possibly because they were aimed at developing the more easily addressed physical skills which many teachers believe they know and understand already, rather than conceptual tools which as I have already explained are so difficult to produce guidelines for.

Initial Teacher Training for D&T

Another pertinent and important focus that needs to be addressed in this paper is the initial training of D&T teachers. Since the mid-1990's when there was a government-led move away from training teachers on 4 year B.Ed courses and towards the, dare I say it, 'cheaper option' of 3+1 routes instead, many researchers have indicated their concerns. Within four years of the change, research by Banks & Barlex (1999) using a sample of 1-year PGCE students homed in on the importance of in-depth subject knowledge for creative and effective teaching in D&T, implicitly suggesting that there was not enough time during a 1-year programme to achieve this. Whilst both Rutland (1996, 2001) and Zanker's (2005) research studies specifically identified the short length of time that 1-year PGCE students could devote to studying subject knowledge as being problematic.

In the late 1990's both Lewis (1996) and Tuffnell (1998) had picked as important factors the varied backgrounds of PGCE trainees and the misalignment between knowledge, skills and understanding acquired on a first degree and what was required to teach D&T. Lewis (1996) also compared the time spent on gaining subject knowledge between those on a PGCE programme and those on longer B.Ed programmes.

Developing concerns specifically regarding designing skills (e.g. Ofsted, 1998; 2000) were chosen as the focus for a research project regarding training D&T teachers by Barlex and Rutland (2003, 2004). This curriculum development project concentrated on developing PGCE students' designing skills and their subsequent use in teaching at KS3. They provided evidence to suggest that there was a lack of trainees skills, a need for extra time to learn designing skills, and a lack of opportunity to use those skills in an educational context once out in a school situation. Their report did not indicate in detail what was implied by 'learning designing skills' although the physical skills associated with designing and making were discussed at length. The difficult and more esoteric aspects of developing a real understanding of the process and what designerly thinking actually is were not the focus of their publications.

By 2008 Martin had concluded from his research that 1-year PGCE trainees would make more competent teachers if they were allowed to specialise in only one area rather than the two expected in the D&TA Minimum Competencies (2003). Although I can understand his sentiments, what a pity it would be if that became the way forward. Where would D&T Heads of Department or Faculty with a broad understanding of the various specialisms within the subject come? It is for this very reason that we at Sunderland designed and have successfully run a 2-year PGCE programme with year one entirely devoted to broadening a graduates D&T subject knowledge base. It is also why we are running a 1-year subject knowledge enhancement course pre-the 1 year PGCE this next academic year for students that require extra subject knowledge, as the TDA has ceased to fund 2-year PGCE programmes.

In an ideal world students without tacit design intelligence, who are accepted onto D&T ITT programmes, need enough time during their studies to carry out several differently targeted design and make projects. Each project needs to have the same underlying aim, that being to develop personal understanding of both physical and conceptual aspects of the process. However, I recognise that it is impossible to return to the halcyon days when our students had time to reflect upon their practice to the extent that they did on 4-year undergraduate programmes. On the other hand, in the shorter time we now have to train teachers the development of appropriate conceptual tools is unlikely to happen if we cannot devote enough time to designing. Somehow we need to provide students with the opportunity to interrogate their own design processes in order that they can see and believe that change is even necessary. They need time to think about the thinking behind their designing. As Ken Baynes (2009) referring to the work of Jane Abercrombie said *"… 'we may learn to make better judgements if we can become aware of some of the factors that influence their formation'. In other words, we should think about thinking as well as thinking"*(p8). Students also need time and support to understand how to overcome misconceptions from the past and have the opportunity to think through and test out new thinking strategies – time when they are not being asked to confuse the issue by having to think about how they could also teach such a project, as the two processes are different (Banks et al, 2004).

Through my own experiences I have come to recognise that discussions on an individual or small group basis are

a useful strategy to adopt. Observations from working with various colleagues support my belief that these discussions need to be led by someone who has the ability to: believe in and understand the concept of thinking about thinking; comprehend the process beyond the physical skills and knowledge required to complete the task; interrogate the mental activity locked behind the visible process found in folios; sensitively discuss misconceptions without alienating the learner; understand that different approaches to designing are required depending upon which D&T specialism is being addressed. I believe that if this is done sensitively and thoroughly using exemplar material and discussions to support a developing philosophy, some students will be able to develop new conceptual tools for themselves. Once this understanding is securely in place then students can more easily convert their subject knowledge into school knowledge and develop appropriate subject constructs that will aid them teach pupils to design appropriately.

As I have already pointed out I am not suggesting that all students fall into this category as there are a number of students each year for whom the conversion from designer with design intelligence to effective teacher of designing is almost seamless. Unfortunately I do have evidence to support my belief that it is a decreasing proportion of each cohort who fit in this category.

The relationship between my research and ability to meet 'the challenge'

In terms of my own research this has emanated out of a mounting concern for this category of student – those with inadequate design skills, and my wish to improve their understanding before they become teachers of D&T. In my own institution I believe the problems stem partially from the fact that we train D&T teachers whose expertise is drawn from all four specialism's, resistant materials, electronics, textiles and food and therefore there is significant variation in their backgrounds and understanding of designing. In addition the students who are coming to us straight from school are arriving with weaker D&T knowledge than in the past. However I consider of greater significance is the fact that we are seeing the students for less and less time. When a D&T teacher was trained on a 4-year degree programme they carried out at least nine minor design projects spread over the first three years of their programme followed by a major design project lasting the whole of their final year. This provided plenty of opportunity to revisit misconceptions and misunderstandings about designing that enabled them to develop their conceptual tools, and the procedural and physical skills required to carry out the process. Now with a 3-year programme and only two of those years devoted to studying subject knowledge, students complete two minor and two major projects, none of which lasts for more than 12 weeks. In an even worse position are our 2-year students. They must acquire enough physical skills to address their two chosen specialisms and the common D&T core as specified in the DATA subject knowledge document, and can therefore only devote enough time to complete one minor design project and one major design and make project during their one-year studying subject knowledge. This year is meant to build on subject expertise gained on an appropriate course such as an HND, which may or may not have included design activity within its syllabus. Whilst our 1-year PGCE students do not complete any design projects at all to develop their personal understanding of the process, bearing in mind that during their first degree many of them may not have completed design activities that provided the required level of understanding about designing that I am referring to in this paper. At Sunderland University all the limited subject knowledge time in the PGCE year is devoted to converting content knowledge into school knowledge and as I have already stated I believe that students training to become D&T teachers cannot work out their school knowledge, how they will teach designing, unless they have a secure understanding of the activity of designing beyond that of the simple models many of them used in the past. I believe that for these trainee teachers the development of their subject constructs using unsound content knowledge leads to the next generation of pupils with unsound designing skills themselves and cyclically will lead to the next generation of D&T teachers with misconceptions a propos the activity.

As I have already mentioned over the past eight years my research has been targeted at clarifying my understanding of the problems these students face. Each of my small-scale projects has been written up as an article or presented as a paper at a conference therefore I will only make reference here to aspects that are pertinent to the topic of this paper.

Firstly, using new understanding that came out of my study for a PhD concerning Key Stage 4 pupils' D&T activity, I targeted the relationship between a university student's preferred ways of learning, their past experience of D&T and their levels of success in the three areas of D&T that we offered on our programmes at the time – those being resistant materials, electronics, and textiles (Atkinson, 2003a). The data collected indicated that there was the expected positive relationship between past experience and achievement, it also highlighted that there

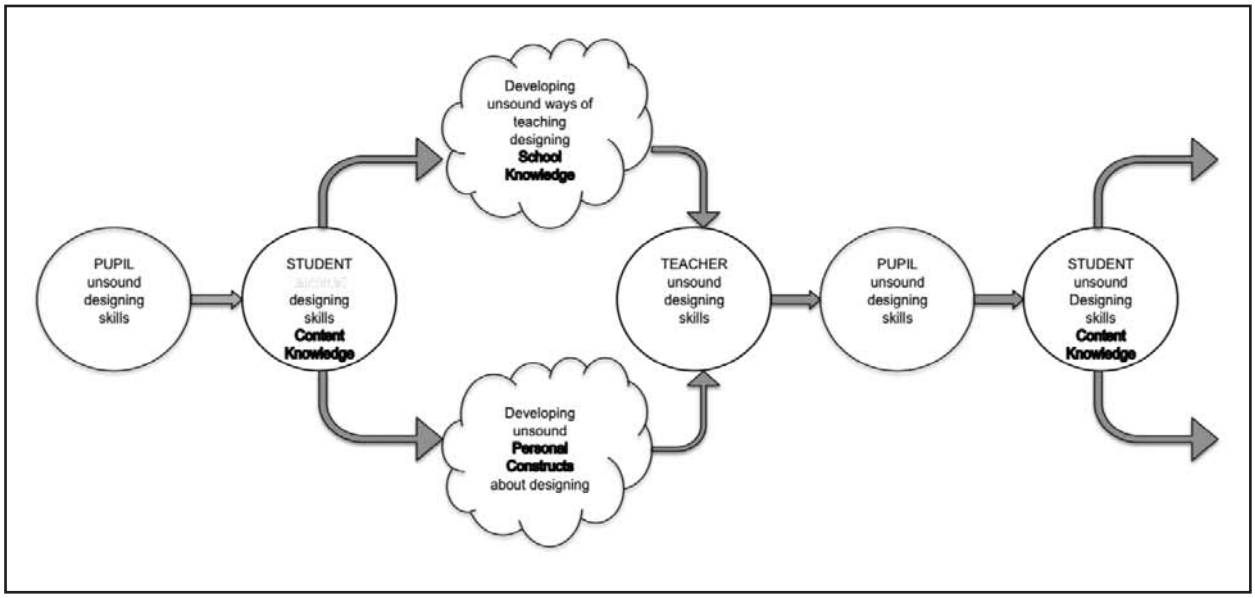

Figure 3. a cyclical model of the consequences of knowledge transfer between teacher and pupil

were differences in achievement in terms of gender and preferred ways of learning although I did not specifically research the differences by specialism as at that time our students did not qualify with identified specialisms.

This project was followed by a study of the relationship between a student's learning style preference, attitude to learning, appropriate prior knowledge and achievement specifically in the context of computer aided learning (CAL)(Atkinson, 2003b). At that time, 2003, the University and others were pushing the use of CAL and we wished to be sure that we were using it appropriately and that our use of CAL was a help, not a hindrance, to a students' learning. The research highlighted the fact that the level of computing skills prior to the course was more important than the prior level of subject knowledge and that preferred learning style was once again seen to be an important factor in a student's attitude to learning and their ability to achieve in D&T.

The next year I set out to compare the relationship between creativity, learning style preference and achievement at GCSE and degree level in the context of design activity (Atkinson, 2004) marrying together the school data I had collected for my PhD with new data collected from two universities. The results regarding the differences between GCSE and degree level are not particularly pertinent to this paper however the data collected did highlight the difference between the two universities in terms of the ages of the students and their conceptual understanding of designing. This led directly into my next piece of research looking at whether the preferred learning style of students differed depending upon their age. I used students from my own institution as the sample, where there were and still are significantly more mature students than school leavers (Atkinson, 2005). The results indicated that there was a difference. The older the student the more able they were to cope with learning materials supporting their design activity that did not match their learning style. The data also indicated that the younger the student the more polarised his or her preferred learning style appeared to be. The consequence of these findings for me was the re-design of the materials I used to teach students about the activity of designing, in an attempt to make them more palatable to all rather than just some of my students. I was also able to use the results to inform my students about the important relationship that exists between learning styles, teaching styles and teaching materials.

This research project was followed by two projects (Atkinson, 2007, 2008) that were carried out once we had added food technology to our portfolio of specialisms. The first study came about from a food technologist's overheard comment 'Why can't I design as well as other people? I thought I understood the process and what was required'. From this starting point I decided to find out how many of my students this statement applied to and to try to identify the challenges that such students faced. Results indicated a larger number of students falling into this category than I had anticipated. This led me into a follow-up small-scale project with the next year's cohort of students. In this project I interrogated the student's design activity in greater depth with the result that I had a clearer picture of the differences between those who would traditionally have

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trained to become D&T teachers (those studying electronics and resistant materials) and the relative newcomers to our programmes, the textile and in particular food technologists. The data collected indicated that there were indeed significant differences in their understanding and attitude towards designing. The analysis also suggested that the length of time the students studied with us, and their relevant prior knowledge were important factors as to whether they were successful or not. Results also indicated a major concern in terms of attitude regarding the broader core aims of D&T rather than the narrower requirements of their major specialism and that this was particularly the case with the new cohort of food technologists.

My research with this year's cohort of students has revisited the concerns identified last year, targeting in particular a student's attitude to D&T, to designing, thinking about their thinking and to teaching DT. I developed and trialled an attitude questionnaire that I gave to the D&T students in each year of all the D&T programmes at my institution. This provided me with eight cohorts and an overall sample of 77. At the time of finalising this paper the final year students who form an important part of the survey were still out on teaching practice and were not easily accessible till their return to the university therefore the data collection is not complete. My actual sample size was therefore only 56 (see Table 2).

However there are some early findings emerging from the data that do impinge upon the topic under discussion. The results would seem to support the belief that the longer students remain with us the better their attitude (see Table 3) becomes towards designing, thinking about their thinking, teaching D&T, and D&T in general. The data collected did not set out to provide answers to the problem but to highlight whether my thoughts about the development of more positive attitudes over time were accurate or not. The results have added to my concerns and my awareness of the need to plan better strategies for my teaching to help change the attitude of these potential teachers of D&T in the future.

Programme	3-year UG			2-year UG		2-year PGCE		1-year PGCE
Cohort	Year 1	Year 2	Year 3	Year 1	Year 2	Year 1	Year 2	Year 1
Cohort size	16	6	0	2	4	17	12	20
Size of sample at present	16	6	0	2	2	17	8	5

Table 2. Cohort size and actual sample size split by programme and year group

Programme	3-year UG		2-year UG		2-year PGCE	
Cohort	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Mean score (max 4.000)	2.989	3.227	2.532	2.966	3.074	3.256

Table 3. Mean scores achieved in the attitude measure split by cohort

	Total mean	Material Technology	Textile Technology	Food Technology
Number in sample	56	19	22	13
Mean score (max 4.000)	3.143	3.166	3.193	3.066

Table 4: Mean scores achieved in the attitude measure split by specialism

Although the picture may easily change when all the data are collected in terms of the difference in attitude between students following different specialism's, it would appear that there maybe significant differences (variance .004, df2, chi square .009, P-value .0089). If we remove electronics from the equation, as there are only two respondents so far, it would seem that food technologists have the poorest attitude towards the aspects of our subject highlighted in the previous analysis. This is therefore something that I need to continue to address in order that food technology students who are with us for short periods of time and whose core design activity has been shown in my earlier research to be problematic are helped to develop a better attitude to the subject in general and designing in particular.

Conclusion

In conclusion I have examined the importance of, and difficulties inherent in design activity within D&T. Using my own research and that of others I have considered a teacher's understanding of designing and thereby a pupil's understanding of and ability to successfully carry out the activity. I have articulated the difficulty inherent in having to think about thinking. I have described the relationships that exist between a teacher's subject knowledge, school knowledge and the development of their personal constructs and how these encroach upon the development of a pupil's designing skills. Finally I have discussed the varied backgrounds of applicants to D&T ITT along with the limited timeframes available on the majority of ITT programmes and how these and other issues effect the development of appropriate attitudes and skills of our future teachers of D&T. Implicitly as a thread throughout my discussion I have inferred how all the mentioned factors impinge upon an NQT's ability to meet the challenge inherent in the theme of the conference 'D&T – A platform for Success'.

Although my paper might sound as though I am despondent about how well our NQT's are able to meet this challenge, particularly in terms of their personal understanding of designing. Maybe I am, because of all the reasons I have described. However I accept the challenge on their behalf and I will continue to develop strategies to encourage my students to think about their thinking, develop pertinent physical skills and conceptual tools, overcome their misconceptions, and assist them to be creative, effective and efficient in the design processes that they use. I will also try to devise ways to do this in the timeframe available, whilst leaving enough time to help them begin to understand how to convert their subject knowledge about designing into school knowledge and start the process of developing sound personal subject constructs – however difficult this might be.
For unless we as trainers of the future generation of D&T teachers accept this challenge and do enable our students to develop a better understanding then a large number of pupils will continue to miss out on the educational benefits that we know are inherent in our subject and in particular in designing. Benefits that make the subject the platform for success that we all know it can be.

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