

## Unorthodox methodologies: approaches to understanding design and technology

Kay Stables & Richard Kimbell  
Technology Education Research Unit  
Goldsmiths College, University of London  
New Cross  
London SE14 6NW

000 44 207 919 7901

email k.stables@gold.ac.uk

### Abstract

Research in technology education is still in its early stages. At an international level, twenty years ago there was only minimal development of that which we now regard as technology education, let alone research that had been undertaken to help us understand its nature or inform its development. The Assessment of Performance in Design and Technology (APU D&T, Kimbell et al 1991) marked a watershed in this landscape, providing a unique opportunity, twenty years ago, to undertake large scale research in this area. However, the repertoire of research into this capability based subject was very limited and the research team included a majority of practitioners. As a result new approaches to understanding capability were explored and developed and new or adapted methodologies were trialed. Since this first project, further approaches have been developed, as methodologies have been borrowed, adapted or created afresh, resulting in a growing repertoire, often including approaches that could be viewed as somewhat unorthodox. The research has been driven by a fundamental desire to understand the nature of design and technology (d&t) capability and the methodologies created to meet these fundamental needs.

This paper will chart some of the territory and development of research methodology in technology education by considering:

- *how* the professional community understood the nature of design and technological capability before the initial APU D&T study;
- the methodology developed through APU D&T - and *why* we developed it;
- subsequent critical projects that introduced further approaches
- illustrations of the repertoire of methodologies developed - borrowed, modified, invented - and how these have helped us develop a more detailed understanding of design and technological capability over the last twenty years;
- a sideways glance at how these developments relate to what others were doing to research technology education and other related areas during the same era.

The paper considers what has been achieved and where new development is needed.

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## Understanding D&T before APU

The decision in 1983 of the (then) Department for Education and Science's (DES) Assessment of Performance Unit (APU) to commission a major research project in the assessment of design and technological capability marked a watershed in the development of technology education. This was the first major initiative where the principal aim was to *find out* about capability and how to assess it, as opposed to developing and introducing new curriculum ideas. This is not to say that this project started with a blank canvas - a whole host of understandings had been developed through the profession grappling with both curriculum and assessment developments. Some of this was instigated and explored at the 'grass roots', other advances were spawned through major national initiatives sponsored, for example in England by Her Majesty's Inspectorate and by the Government funded Schools' Council and Design Council. Two particularly significant developments came through curriculum development projects introduced in the late 1960s: Project Technology, led by Geoffrey Harrison and the Design, Craft and Education Project (the 'Keele' Project) led by John Eggleston (Penfold 1988). Both projects worked closely with teachers to support and develop their practice and produced a range of resources to do this - magazines, text books, pamphlets and so on. The 'Keele' Project most importantly introduced (in 1967) the magazine 'Studies in Education and Craft', but while the articles in the early years illustrate a rich seedbed of shared ideas, as is illustrated in the 20th Anniversary 'best of' publication (Eggleston 1987), very few make reference to other literature or research and even fewer can be seen as ostensibly reporting on research. Further understandings were developed and shared through the various professional associations and a final set of understandings came through developments in national assessment systems. Again in the English context, of major significance was the Oxford 'A' level Design exam, with its criteria based on designing process and on descriptors of levels of attainment; the London 'O' level Design and Technology 'pre-practical' exam paper - a 'designing' exam prior to a formal making skills practical test; and, in 1985 guidance for the (then) new GCSE framework that focused assessment on 'what pupils know, understand and can do' (ie capability).

A related area of growth, that was stealing a march on d&t education, was that of design research, with the interests of the Design Methods movement in the 1960s (Jones 1970), the formation of the Design Research Society in 1967 and the introduction of the Design Studies Journal in 1979. This area had a direct impact on the birth and development of design education, and most notably the Design Education Unit at the Royal College of Art, the establishment of the National Association for Design Education (NADE) and the Design in General Education Project (Archer et al, 1979), all of which had a significant influence on a faction of teachers in the subjects that were precursors to d&t. And just as some were seeking understandings from the design profession, so others were seeking insight from the professional worlds of science and technology.

In virtually all of the above, the emphasis on research was either slim or non-existent and so, for the UK, the creation of the APU was significant as it provided the resources to create the first explicitly research-led development, enabling dedicated teams to undertake both fundamental and seminal work. The DES created the APU in 1975 to conduct surveys of performance initially in maths, English and science, predominantly at ages 11 and 15. A small number of additional surveys and reports were undertaken (in modern languages and aesthetics for example) and finally the single major survey in d&t. Leading to this survey was a working group

(APU 1981) and a subsequent survey of d&t activities in the curriculum conducted by a team at the National Centre for School Technology, led by Geoffrey Harrison (APU 1983).

### **Methodologies developed through APU D&T (1985-1991)**

This early work provided the impetus for a full survey and the APU D&T project started in 1985. Its overarching brief was to monitor the design and technological capability of the nation's fifteen year olds (ie England, Wales and Northern Ireland). In keeping with previous APU projects, this was to be achieved by surveying a 2% sample of this population, which amounted to approximately 10,000 young people. Methodologically this presented a real challenge - nowhere else in the world had there been a similar research project in the growing area of technology education - either in scope or scale. There was no model from within the discipline for the team to refer to, which led us in the first instance to explore existing approaches in other educational disciplines, and in particular from previous APU projects. Particularly influential was research that focused on assessing *process* – especially APU research in language and in science investigations. Added to the immaturity of research in technology education was the immaturity (in research terms) of the project team - all of us experienced curriculum practitioners with strong understandings and beliefs about classroom practice in d&t, but who in research terms could, between us, muster one M.Phil. and 2 MA.s.

In order to address the brief - of monitoring capability, we had two overarching drivers: to develop understanding of capability we had to be able to *understand process* and to *assess performance*. As practitioners, the team established early on a commitment to the definition of d&t capability that had been developed through the earlier work of the working party and subsequent 1983 survey - that the capability was procedural. Further we developed a belief that to assess procedural capability assessments had to be conducted 'on task' in 'real' or 'authentic' settings. Methodologically this left us in very new research territory. While this was daunting, it did provide us with a clear, overarching criterion both to guide and defend our choice of research approach and, as it turned out, to develop the first of what could be seen as a growing repertoire of unorthodox methodologies. We prefigured our position on this in the opening statement to the final report of the APU D&T project.

There is no single, all-embracing approach to research in education. There are many approaches- indeed new approaches are constantly emerging as researchers tackle different kinds of problems and devise strategies to suit them. And so it is necessary not only to select the approach that is most suitable for any particular research undertaking, but also to demonstrate why it is more suitable than other approaches that might have been chosen. (Kimbell et al 1991:11)

In our quest to understand process in d&t we explored previous models and were frustrated by the stranglehold of linear and cyclical models that were more about managing the process than describing its reality. Through this project we sought to develop a different model that captured a more responsive and dynamic (if complex) conception of the process. We characterised the process as starting with a hazy idea that needs to be externally expressed in some way (drawings, writings, talking, modelling) in order that the idea can be seen more clearly and subsequently thought about more deeply to allow a further and more developed expression of

the idea to be iterated. Figure 1 is how we illustrated the model in the final report of the APU d&t project (Kimbell et al 1991) and in writing about this some years later we summarised our model it in the following way.

The approach ... is built on a profoundly different model which views designing as an interaction between mind and hand (inside and outside the head) and the activity as being best described as iterative as ideas are bounced back and forth; formulated, tested against the hard reality of the world and then reformulated. We coined the phrase 'thought in action' to summarise the idea. (Stables and Kimbell, 2000:195-196)

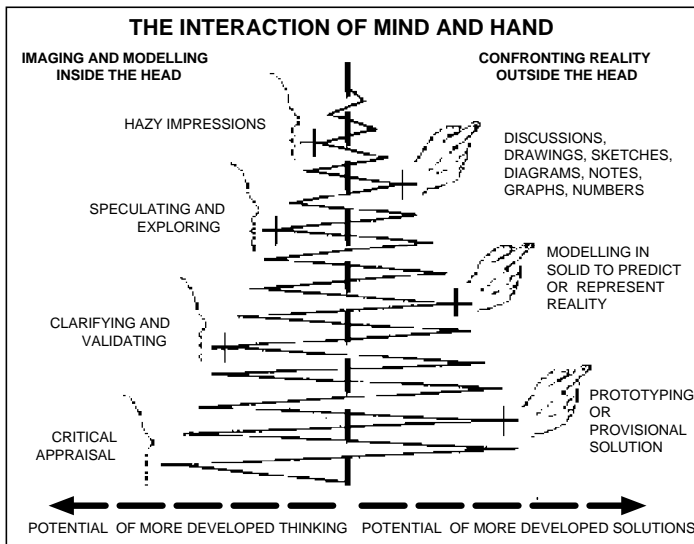


Figure 1: The APU model of interaction between mind and hand (Kimbell et al, 1991 p. 20)

To develop an appropriate assessment framework derived from the above model we did not turn to research methodologies, but to our own experiences of assessment as practitioners through which we believed that teachers could make reliable and valid overarching judgements about the quality of a given piece of work. This led us to a position where we saw the first and foremost assessment of a d&t project as being *holistic* - taking account of the total of what a learner was trying to achieve and the way they were going about it. From this we could analyse the work in more detail and make separate judgements about dimensions of the process - how effective was the evaluating, the generating of ideas, the planning and so on. Finally we could look in greater detail still to describe what the learners had done - what actions lay behind the quality of their evaluating. We created a three level assessment framework which allowed us to start with an holistic judgement - the 'big picture' of what had been achieved and then progressively dig deeper into the work as we increased the magnification through our questions and criteria. Within the framework we distinguished between those aspects where *judgements* were to be made (largely relating to procedural matters) and those where the questions allowed for a *cataloguing* (or mapping) of the terrain of the response, through simple yes/no answers (eg have they used colour? Yes/No). Building this level of detail allowed us to create a unique profile of each response - effectively 'fingerprinting' it. The framework and our approach within it are described in detail in project documentation (Kelly et al, 1987, Kimbell et al, 1991).

In order to assess capability in the context of real activities two different approaches were taken. The first of these was simply to assess project work that was underway in schools through requirements in the (then) new GCSE coursework requirements. The second was to conduct a series of differently structured but standardised assessment activities through an approach that we have come to term the 'unpickled portfolio'. (Stables and Kimbell, 2000). For both approaches there were a similar set of methodological matters to be considered - how evidence was to be generated, how data was to be collected and how approaches were to be standardised across the survey population.

For the assessing of project work the basic evidence - the learners' project work - was generated through their individual responses to the briefs set by the GCSE examinations. The sheer challenge of monitoring project work that was going on over extended periods of time meant that the learners involved in this aspect of the survey were necessarily small in number - only 210 in the final count. Reporting was through illustrative case studies developed from the collection a whole range of evidence including photocopies and photographs of work, tape recordings and written notes of interviews, a detailed charting of the project work (deploying the assessment framework outlined above), the teacher's assessment, learner self assessment and school background data. As such this built very much on standard research methodologies adopted from elsewhere.

For the assessment activities we were on new ground - caused by the need to address both our determination to bring assessment to bear on authentic d&t activity and the sheer practicalities of conducting a survey involving 10,000 subjects. Our response to this was to develop a network of activities, structured through an unfolding response booklet and choreographed by an administrator's script that enabled learners to provide a rounded d&t response in a tight time frame of either 90 minutes (involving only paper and pencil) or 150 minutes (allowing also for 3D modelling and discussion of ideas), depending on the activity. The response booklet helped learners in both generating and collecting the evidence. The activity was standardised by the administrator's script, and through the provision of identical resources to all participating schools, including for each activity a short (7-9 minute) contextualising video programme to set the scene for the design task. The assessment was standardised by the assessment framework, accompanying rubric and assessed exemplars and by the careful training of the assessors. (see Kimbell et al 1991 for more detail)

In relation to the response booklet, there were a number of key innovations. The first and most obvious was the way in which the booklet unfolded. One of the constraints of the survey was that the learner's response had to be in some form of booklet and yet we didn't want to use a conventional booklet that involved turning pages and hence concealing the work already done. The activity was structured as a design task that was made up of a series of iterative (between 'thought' and 'action') steps. In response to our self imposed problem we designed a booklet that unfolded to progressively reveal the next step without concealing what had gone before. Figure 2 takes one example - the 'Early Ideas' test booklet - and illustrates how this worked. In addition to the way the booklet worked, there were a number of other key features that have become threads through future work:

- the use of 'red penning' - encouraging learners to evaluate their own work in an explicit fashion during the course of the activity;
- the use of everyday language such as 'put down' and 'jot down' as a way of not prescribing drawing or writing as a format for communication;

- the requirement for the learners to identify, at the close of the task, what they don't know but would need to find out if they were to take their design through to a finished outcome.

These features were all methodological tactics designed to make tangible the thoughts that lay behind the learners' actions - in order that the assessment could be made more reliably. As it turned out they also had a value to the learners - for example in providing the 'pause for thought'. On reflection, we are aware that the methodology was working at a number of levels - the unfolding booklet was an unconventional research tool in itself, and the collection of unconventional tactics it presented made it work for the learners as well as the assessors.

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Figure 2 - The unfolding booklet

A final theme emerging from this first project relates to the way we presented data. It may be the very nature of our backgrounds in design, but from this first project onwards, we have sought to find graphic ways of presenting findings that makes them both clear and accessible. This has tended towards presenting data in 'non-standard', *quirky* ways. Our approach developed from the problem of dealing with large and complex data sets and, in outline terms our process was to collect and secure valid and reliable raw data and then to make pictures from the data to help us explore emerging patterns. The patterns in turn led to us creating pictures that allowed us to illustrate the patterns to others. There were a range of ways we went about this in the APU D&T project and we present just two examples here. The first is to do with the way the actual data is arranged. We had gathered performance data in relation to both gender and ability and wished to explore the difference in impact of the test structures in the survey. We had the absolute performance scores as a mean for each group, but wished to explore the difference between the groups. To do this we held the mid ability girls as a constant

and arranged the data to show how much better or worse the high and low ability girls' performance was. We also arranged the data from the most open of our test structures (the 150 minute modelling activities) to the most tightly structured (a 90 minute paper and pencil test focused on evaluating products). The resulting chart is shown below and, in a very graphic fashion, illustrates quite clearly how the more tightly framed tests supported the performance of the lower ability girls.

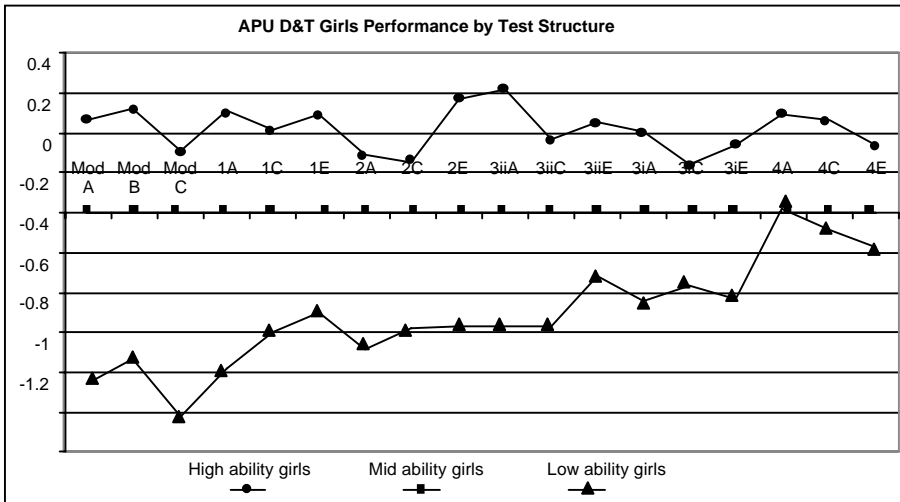


Figure 3 The performance of girls organised by test structure

The second example shows how we presented schematic pictures of performance, across the survey, in a visual way that showed patterns that would have been somewhat harder to detect from the basic data. Figure 4a shows basic data of average performance by girls and boys in each test. Figure 4b uses this data to show visually the overarching effect of the context of the test (in contexts of designing for people, environments or industry) and Figure 4c uses the data to show the way the test structure effect overlaid the context effect.

Figure 4a Basic data

APU holistic performance by context (A, C & E) and gender

\* indicates 5% sig.  
\*\* indicates 1% sig.

	People	Environment	Industry
T.1 Boys	2.19	2.03	1.71
T.1 Girls	2.42 *	2	1.95*
T.2 Boys	1.89	1.77	1.99
T.2 Girls	2.02	1.85	2.21**
T.3i Boys	1.97	2.23	1.87**
T.3i Girls	2.06	2.19	1.58
T.3ii Boys	1.96	1.8	2.41
T.3ii Girls	2.08	1.77	2.29
T.4 Boys	2.15	2.09	1.96
T.4 Girls	2.5**	2.40**	2.29**
Mod Boys	2.29	2.55	2.65*
Mod Girls	2.38	2.37	2.38

Figure 4b Context effect

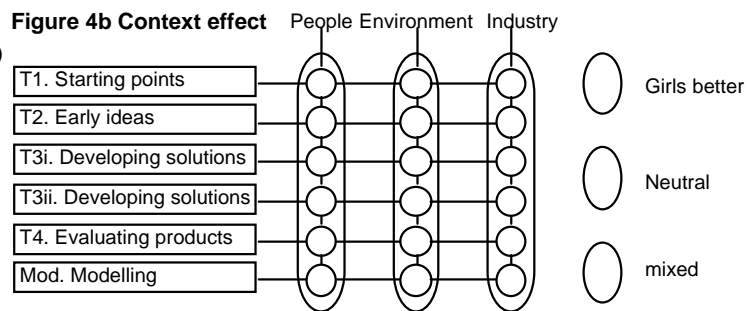
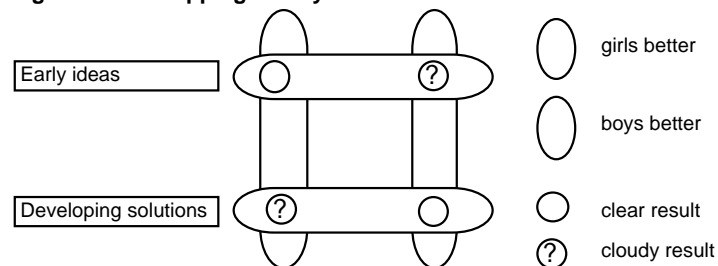


Figure 4c Overlapping survey effects



Figures 4a, Basic data from the APU d&t survey; 4b, Context effect and 4c Overlapping survey effects

Looking back over the research we have undertaken in TERU in the last twenty years we are conscious of a number of themes that have emerged, all of which to a greater or lesser extent can be seen in this first project:

- The '*by products*' from gathering *ephemeral* evidence (e.g. the assessment booklet was structured to gather the 'thinking' of the learners - and in doing so gave them the opportunity for a 'pause for thought')
- Approaches to assessment (e.g 'fingerprinting' the responses through a combination of levels of valuing and describing within an overarching holistic judgement);
- The use of the *vernacular* in terminology (e.g. 'put down ideas' and 'jot down problems' rather than specifying 'write' or 'draw');
- The *quirky* ways of presenting findings (e.g. the effects of context and test structure on performance);
- Combining *qualitative* and *quantitative* data (e.g. the use of case studies for extended project work).

### **The repertoire developed by TERU post APU**

From the end of the APU project to the present day, a further twenty projects have been undertaken by TERU. This paper will consider three further projects where distinctly different approaches were used and through which the themes identified above can be illustrated. The first of these, the *Understanding Technological Approaches* project (Kimbell, Stables and Green, 1994) developed an approach to observing and documenting the fine detail of actions undertaken in a range of d&t projects. The second, the *North West Province Technology Education Evaluation Project* (Kimbell and Stables, 1999), was the first curriculum evaluation project we undertook and illustrates both how we developed the APU 'unpickled portfolio' and also developed approaches to gathering opinion based data. The third, *Assessing Innovation* (Kimbell et al, 2004), took forward the assessment focus but with an emphasis on creativity and innovation. The following sections provide an outline of these projects and examples that exemplify methodological developments in relation to the above themes.

#### *Understanding Technological Approaches (UTA) (1992-1994)*

There were two fundamental areas of understanding that the APU D&T project did not provide insights into. The first was the fine detail of how learners engaged with *complete* d&t projects over time and the second was the extent to which capability varied between age groups. A subsequent project, the Understanding Technological Approaches (UTA) project (Kimbell et al 1994 & 1996) aimed to explore these areas by monitoring, minute by minute, the complete d&t projects of eighty learners spanning all age groups from five to sixteen. This demanded a methodological approach that allowed for close observation and analysis. We faced the problem of monitoring and recording the huge detail of a complete individual project – and monitoring more than one learner at a time. We had to establish what was important to observe and record and what to ignore. To do this we went into classrooms in pairs and through a process of observation and subsequent analysis devised categories that we considered meaningful in terms of understanding the activity and that allowed for recording the observations in a consistent and manageable fashion. The analysis resulted not just in the creation of the categories, but for each category a set of pre-coded data sub categories. Central to understanding d&t capability were the categories of d&t *intentions* and *manifestations*. This allowed us, for example, to explore the different ways in which learners approached the intention of developing an idea - did

they do this by drawing, by talking to each other, by combining materials or in some other way? Through the development of the iterative model of designing in the APU d&t project we were clear that the dimensions identified in linear models of designing (eg. generating ideas, making, evaluating) were better viewed as design intentions, rather than 'stages' in a fixed process, and that these could and would change in response to the needs in any particular design task, depending on the way in which the learner tackled it. By collecting this data across the length of a project we potentially would have proof-positive of our belief. Three further categories articulated were; learner engagement, teacher/learner interaction and focus of the project (ie technical, user or aesthetic). In addition we collected narrative data that provided a context through which to understand the coded data. Five minute time slots provided sufficient detail to capture the project in a meaningful way and enabled an individual observer to record data on four projects at a time. Figure 5 shows the structure, categories and sub categories of data collected.

name				narrative				generating mod exploring developing modify detailing constructing planning organising investigating receiving evaluating reviewing recording explaining presenting seeking help intentionless	discussing thinking aloud looking drawing reading writing listening waiting arranging selecting measuring marking out	making -cut - join - fit - mould - mix - finish - base - add preparing testing cleaning up off task	
S	P	M	time								
dir		sup									
T	C	M									
<b>Observation forms - definitions</b>											
<i>Level of engagement</i>				<i>Teacher intervention</i>				<i>Issues child is dealing with</i>			
S = Stationary:				dir = direction:				T = Task issues:			
P = Poddling:				sup = support:				C = Communication issues:			
M = Motoring:								M = Making issues:			

Figure 5 The observation schedule from the UTA project

### UTA project: Combining qualitative and quantitative data

There were certain novelties in our approach. First we collected both quantitative (coded) and qualitative (narrative account) data. The narrative account was essential both to understand the context that the learner was operating in and also to verify and understand the coded data. The coded data varied from very objective data - particularly that which identified the manifestations where it was absolutely clear (for example) whether the learner was cutting material, measuring or writing, to quite subjective data - for example in identifying the design intention of the learner it sometimes required an element of inference on the part of the observer. At the time at which we were doing this, other researchers, within d&t education and also within the design profession, were exploring the related approach of 'protocol analysis'. That which equated most closely to our approach was research that of Rob Johnsey was undertaking with primary age children's d&t activity where he was applying a procedural analysis on a minute-by-minute analysis of video footage. (Johnsey, 2000). Amongst his conclusions was one that echoed our own findings.

The evidence from the behavioural charts suggests that when children are given a free hand to design and make, the making stimulates the designing and vice versa. It suggests that children do not plan everything at the beginning and then proceed but that planning runs in parallel with doing. Furthermore, it seems quite natural for children to change and add to the specifications they have for

their product as they proceed. It is as though the half-completed product acts as a stimulus or modelling tool for new ideas. (Johnsey 2000: 20-21)

More explicit exploration of protocol analysis as a tool to understand designing was taking place in the world of Design Research. A major workshop in 1994 in Delft, took a rigorous, explicit technique of Protocol Analysis, wherein the participant designers spoke their thoughts 'out loud' throughout their designing. (Cross, Christians & Doorst, 1996) While the workshop was found to be of immense value, the authors reported that it was useful to capture certain aspects of activity in great detail, but that focusing entirely on what was communicated by out-loud thinking missed other forms of communicated evidence.

The adoption of protocol analysis as a research technique for design is an effort on the part of design methodologists to find a rigorous form for their empirical research. Protocol analysis is somewhere in the middle ground between the 'hard' experimental methods of the natural sciences and the 'weaker, purely observational methods of the social sciences. (Cross et al, 1996: 13-14)

The approach we had created for ourselves had certain similar characteristics, but perhaps (somewhat unwittingly) bridged the gap between the approaches of the natural and social sciences, particularly in the way we were collecting 'hard' quantitative and 'soft' qualitative data. Perhaps of most importance in our case was that we weren't seeking to bring a methodology from elsewhere to bear on what we were doing, but to create one that allowed us to gain insight into the processes learners (and their teachers) were employing. Seeking to collect both quantitative and qualitative data at the same time is more acceptable in 2005. Researchers who might previously have identified themselves with either a qualitative or quantitative research tradition are realising the valuable insights that can be gained by combining the two. In 1993, the approach was somewhat unorthodox and the richness that it enabled convinced us of the value of the combination.

#### *UTA project: The use of the vernacular in terminology*

A further novelty growing from the APU d&t project was the use of 'everyday' words to capture the spirit of our observations. Our need was for consistency in monitoring and recording data across the research team and everyday language proved a reliable way of sharing understanding. This appeared most notably in this project in the way in which we coded the learner's engagement - by identifying their activity level at any given time as 'stationary', 'poddling' or 'motoring'. These terms emerged early in the project as the team found how easily and reliably they could be used and, in analysis terms, how effective they were as discriminators of engagement and motivation. When disseminating the project we also came to realise the 'added value' of the use of these graphic, vernacular words terms that also helped teachers to share our understandings, despite being idiosyncratically English (the word 'poddling' has initially foxed international audiences).

#### *UTA project: The quirky ways of presenting findings*

As with the APU D&T project, we explored different ways of presenting findings in order to see the emerging patterns – and analysing the incidence of 'stationary', 'poddling' and 'motoring' provides a useful illustration of this approach. The problem we were addressing was how to compare the varied levels of engagement between age groups and also across the differing timespans of the projects, the shortest of which (with 5 year

olds) was 3 hours, the longest (with 16 year olds) was 50 hours. To do this, we divided each project into five equal phases that allowed us to show variations in the 'big picture' of the project. Figure 6 shows our approach to this, providing a comparison of the average 'motoring' by learners in Key Stage (KS) 1 (5-7 year olds), KS2 (8-11 year olds), KS3 (12-14 year olds) and KS4 (15-16 year olds). Following the 'motoring' line for the very young children their sheer enthusiasm and energy can be seen, and also the dip (probably in energy level) before building up to the crescendo of completing the project. This compares quite starkly with the pattern that emerged for the 11-14 year olds where a more prescriptive, linear pedagogic approach appears to have depressed engagement in the early 'paper work' stages, lifted it once they got their hands on materials and saw it begin to fade away as final evaluations were being required of them.

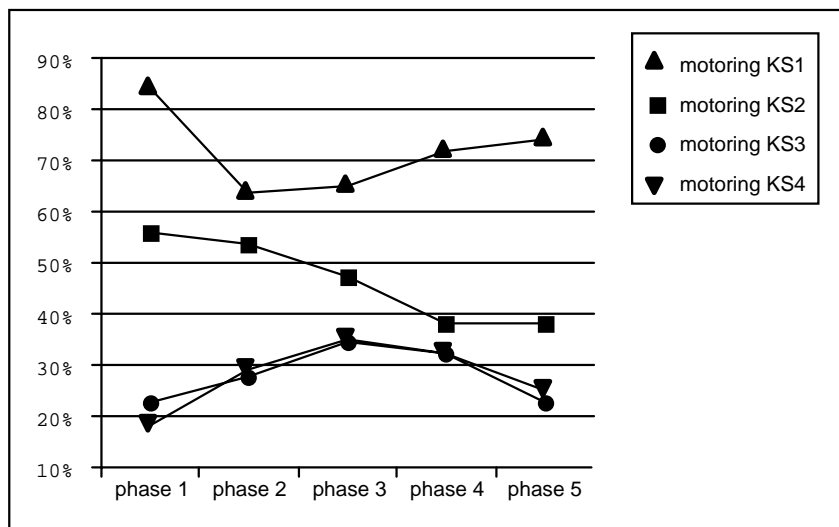


Figure 6 A comparison of 'motoring' across the key stages in the UTA project.

#### *The North West Province Technology Education Project (NWPTEP) Evaluation (1998-1999)*

This next project was an evaluation of a curriculum initiative undertaken in the North West Province of South Africa involving senior high school learners (16 year olds and above) from schools in both rural and urban communities. The initiative, funded by the UK Department for International Development (DFID), aimed to introduce a technology education curriculum into high schools and was part of the much larger 'Curriculum 2005' project. It implemented an approach that promoted mixed gender, participatory, collaborative group work, utilising a problem solving model of designing - an approach that was entirely new, both because technology education was new, and also because learning was more typically by rote, through teacher directed lessons.

#### *NWPTEP: The 'by products' from gathering ephemeral evidence*

The evaluation, also commissioned by DFID, looked at the impact of the project, the focus of which was not on what the learners knew, but what they did with what they knew - the quality of their *procedural* capability. To assess this we once more needed a tool that could be used 'on task' - to assess performance in an authentic way - and again utilised the 'unpickled portfolio' approach of the APU d&t project. However, the assessment needed to reflect the group work approach of the NWPTEP. To address this the APU structure was modified such that a mixed gender group of 6 learners worked together, with sub-tasks dividing the group into three pairs. Because the evaluation project was designed to measure the impact of the NWPTEP by comparing a whole cohort of learners who had experienced the project with one that hadn't, the assessment could measure

the performance of the team of six learners as a whole, rather than individually. Our initial reaction was that this allowed us to avoid the thorny issue of assessing team work. However, when we trialed the activity it became apparent the test booklets provided a trail of evidence indicating how effectively the team had worked together. Thus in structuring the response booklets to support groupwork activity, we had inadvertently also captured evidence for assessment. This was a turn-around from our previous experience where, for example with the 'red penning' we had structured for assessment and inadvertently provided a format that supported the learner. We took advantage of this to use the evidence to develop criteria for assessing 'team working' within our assessment rubric.

*NWPTEP: Combining qualitative and quantitative data*

The NWPTEP provided so distinctive a shift in both curriculum and pedagogy that we wished to gain as much insight as we could from the learners themselves. To this end we conducted semi-structured group interviews, an activity evaluation questionnaire and an 'attitude to technology' questionnaire (derived from earlier PATT type research conducted by Dyrenfurth and Williams (Dyrenfurth 1995). This included inviting the learners to identify: the aspects of an activity that made it a 'technological' activity; what they believed technology to be; and the extent to which they agreed with a range of statements about 'technology in the world around us' and 'learning technology'.

The attitude questionnaire captured solely quantitative data but the activity evaluation collected both qualitative and quantitative, particularly in gender issues. Both questionnaires were coded such that we could connect up the responses of any one learner and this allowed a rich analysis of gendered responses showing, not least, how powerful the impact of the new technology curriculum had been on developing amongst both boys and girls very positive views about each other and, amongst the girls, a very strong sense of empowerment and self worth. Figure 7 shows examples of the range of ways this data was collected.

**From the Activity Evaluation Questionnaire ...**

ABOUT GIRLS AND BOYS WORKING TOGETHER

4. Was the partner you worked with today a boy or girl?  boy  girl

5. Do you think you worked well together?  very well  well  OK  poor

6. What are the best things about working with BOYS?

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7. What are the best things about working with GIRLS?

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**From the Attitude Questionnaire ...**

14. Girls think technology is difficult

18. Technology is only for girls

22. Boys and girls should learn about technology

35. Girls' attitudes to technology are different from those of boys

Figure 7 The gender explicit data collected from the Activity Evaluation and Attitude Questionnaires

### *Assessing Innovation (2002-2004)*

With the publication of the revised English National Curriculum in 2000 (NC2000), a Strategy Group for d&t was established to steer the subject through the following years. The group quickly became concerned about the lack of internal coherence between the 'vision' statement for d&t (as presented in NC2000), and the Programmes of Study and Attainment Target the document also provided. In particular the vision statement encapsulated the importance of creativity, innovation and teamwork whilst the Attainment Target was starkly bereft of any reference to, or recognition of, these factors. In addition, related problems were noted with current GCSE assessments - that GCSE project work had become formulaic and routinised – and that innovative learners were potentially being penalised by comparison with well organised, rule-following learners. For these reasons, the Strategy Group commissioned TERU to develop a system of assessment that would measure and reward creativity and innovation.

To take on this challenge the team worked closely with both teachers and those developing and monitoring assessment for GCSE (the Qualification and Curriculum Authority and the Awarding Bodies). The project was structured through three overlapping phases: *creating descriptors* to inform the development of an assessment framework for creativity and innovation by analysing existing project work that was identified by the teachers as being either 'pedestrian' or 'innovative'; *creating evidence* by supporting teachers to develop two-day d&t projects aimed at facilitating creativity and innovation; and *creating assessment activities* focused on creativity and assessment, based on the 'unpickled portfolio' approach.

### *Assessing Innovation: The 'by products' from gathering ephemeral evidence*

A resounding feature of the unpickled portfolio approach has been the capturing of evidence that might otherwise have been lost (such as the learner's evaluative thinking) and a 'by product' of this has been the way in which tactics employed to collect evidence have been genuinely supportive to the learner. In the Assessing Innovation project the most interesting and successful example of this came from addressing the problem of capturing evidence of 3D modelling of ideas. From the activities developed in Phase 2 it became apparent that if teachers were creating activities to explicitly support creativity and innovation, they encouraged the learners to engage in generative work early in the activity, often through 3D modeling using quick and accessible materials such as paper and card. This strategy was very productive but the question we faced was "how do we capture the evidence?".

The answer came through developments in digital technology - we structured into the activity (and the test booklet) a periodic taking of a digital photograph of the developing models which were printed and returned to the learners to stick into a growing 'photo storyline' in their response booklets. In doing so we gathered the (erstwhile) ephemeral evidence of the various personas a model had held in the course of its development. This served our purpose very well, but what we hadn't anticipated was that the learners found it a great impetus to their own thinking.

### *Assessing Innovation: The quirky ways of presenting findings*

Having found that we could successfully capture evidence of the development of an idea through digital photographs we experienced the frustration that, although the photo stories allowed us to present the data visually as a set of images, we couldn't show the active growth of the modelling. Once more digital technology came to our aid by providing the facility to 'morph' the still images into a movie, presenting very clearly and powerfully, the evidence of innovation in a dynamic format.

*Assessing Innovation: The use of the vernacular in terminology*

Once again in this project we found ourselves building shared understandings both with the research team and with those we were working with in the broader d&t community, through the use of the vernacular. The first instance grew out of the exploration of descriptors where, in searching for the opposite ends on an innovation continuum we found ourselves using the words 'wow' and 'yawn'. These terms encapsulated an instant, agreed scale that we went on to use in developing criteria for the 'holistic' mark. Figure 8 shows the statements that characterise the four points on this continuum.

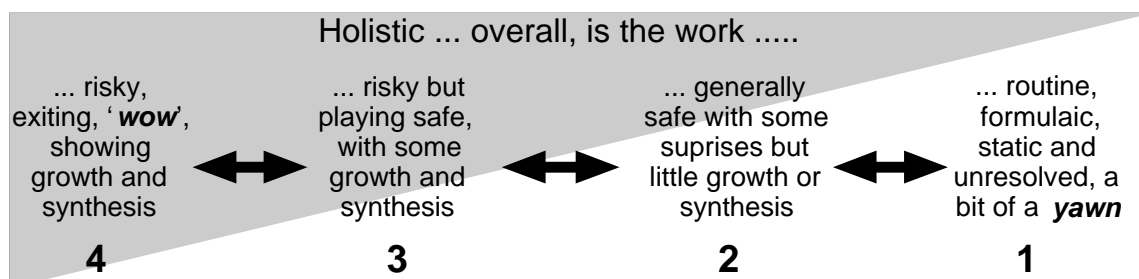


Figure 8 The 'holistic' wow <---> yawn continuum

**Reflections on the approaches we developed**

The development of d&t prior to the APU survey depended in only a limited way on research - it was led predominantly by practitioners sharing ideas. While in many ways this was very positive, there is a danger that this situation provokes a cyclical, re-inventing-of-wheels approach. Richard Andrews identified this in his introduction to Eggleston's *Teaching and Learning Design and Technology: a guide to recent research and its applications* (Andrews 2000).

Internationally, the gap between research, policy and practice in public life has become a matter of concern. When professional practice - in nursing, education, local governance and other fields - is uninformed by research, it tends to reinvent itself in the light of a range of (often conflicting) principles. Research uninformed by practical considerations tends to be ignored by practitioners, however good it is academically. (Andrews, 2000: ix)

With the APU d&t project came the big opportunity for large scale, empirical research where methodologies were developed specifically to address the research issues identified. From this first project onwards, starting from issues rather than methodologies led us to develop approaches that didn't sit within any one methodological camp, to develop both quantitative and qualitative approaches. During the same twenty-year period, others, both in the UK and elsewhere were identifying research needs in the subject and also expressing

concern at the limited way the emerging discipline area was being researched. In identifying how our own work relates to these concerns, certain key issues can be highlighted.

A strong thread of commentary has been developed by technology education academics in the USA, particularly calling for a move beyond the traditions of quantitative methodologies. Zuga (1994) - reviewing research in USA up to the early 1990s, found it to be narrowly and inwardly focused, with an emphasis on quantitative and descriptive research. Her view was that the predominance of this type of research marginalised qualitative and interpretative studies. Also she considered that too much focused on curriculum and that more was needed on technological literacy and 'instructional techniques'. Hoepfl (1997) also made a plea for more qualitative research in technology education that provided answers to significant and deep research questions. She pointed the finger at traditional views maintained in some universities, although she detected a change in attitude.

In the past, graduate students contemplating the use of qualitative inquiry were told that they would have to "sell" the idea to members of their research committees, who would probably view qualitative research as inferior to quantitative research. Fortunately, in most universities that belief has changed, to the point where qualitative research is the paradigm of choice in some schools. In spite of this growing acceptance, new researchers may still encounter difficulties in finding faculty advisors who are skilled in this type of research. (Hoepfl 1997: 61)

Petrina (1998) focused his concerns less on methodology, other than the need for more critical theory, and more on the need for a political and interdisciplinary approach to research, which he found to be largely missing in the technology education literature. In responding to Petrina, Lewis (1999) identified a range of types of research questions that technology education should be addressing - of particular interest in relation to the focus of much work in TERU this included questions relating to technological literacy; technology and creativity; gender in technology classrooms and curriculum change. He also echoed Hoepfl's concern with the need to move to more qualitative approaches to research and pre-figured Roberts opening address to IDATER 2000 in which Roberts (2000) made a strong case for greater involvement of teachers as researchers.

The key to how the field views research priorities in the future will depend on the willingness of researchers to range beyond the traditional positivistic paradigm toward phenomenological and critical modes. In particular, teachers would have to be encouraged to be researchers in their own right, or collaborators in research. (Lewis 1999: 51)

Lewis goes on to refer to Eisner's (1993) view that educational research has room for 'many mansions' and declares that

We in technology education must employ the paradigm that can best answer the questions we wish to have answered. If we stick to tried and true paradigms, the consequence is that certain key kinds of questions will not be asked or answered. (Lewis 1999: 52)

Lewis's plea accords well with our approach in developing an array of methodologies that can now be drawn on by others. These have included qualitative, interpretative approaches and have enabled us to grapple with fundamental questions about capability, learning, teaching and assessment. Within this we have, wherever possible, involved teachers as part of the research – addressing in part the issues raised by Phil Roberts. But reflecting on the above, also critiques what have we not done. Have our methodologies contributed to the critical theory that Petrina makes a case for, enabling political, social and cultural agendas in technology education to be taken forward? How do we stand up to the concerns raised by Zuga around insularity? Have we shared our approaches beyond researching d&t, or properly taken account of innovative methodologies?

In truth we (and the majority of those involved in d&t or technology education) have not paid as much attention to these issues as they deserve. The repertoire that is now our legacy has been important in the development of the discipline. But now, new research questions, including those raised above need to be framed - and appropriate methodologies applied to addressing them - whether tried, tested and orthodox, or necessarily pushing at the edge of new and potentially unorthodox approaches. Finally, reflecting on the wisdom of Eisner.

'Because I am a conceptual pluralist, I believe it is important from an epistemological perspective for scholars to have available to them different methods for the study of education. Different methods make different forms of understanding possible. Hence, I am seeking neither a new hegemony nor a new orthodoxy, but rather the expansion of the utensils in our methodological pantry.' Eisner, 1993: 54-55

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