edited by clare benson and wesley till

second international primary design and technology conference

quality in the making

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Second International Primary Design and Technology Conference – Quality in the Making

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DEDICATION

The publication is dedicated to primary children worldwide, who should have the opportunity to study design and technology education as their entitlement.

Introduction

Following the highly successful First International Primary Design and Technology Conference, in June 1997, we are delighted we have hosted the Second International Primary Design and Technology Conference, held at the Apollo Hotel in Birmingham, UK from June 25th to June 29th 1999.

Primary design and technology education continues to develop world-wide and its value is increasingly recognised. The conference provided an excellent forum for dialogue, debate and interaction with colleagues who all share the same interest-that of the continuing development and implementation of primary design and technology education in their own countries.

This publication contains the Keynote addresses, research and curriculum development papers from the Conference.The contributors were from a variety of backgrounds and brought with them a wealth of experiences to share with colleagues from around the world. The Proceedings are intended to be an invaluable resource for policy makers, researchers, teacher trainers, teachers and students, and we hope that you find it both interesting and informative.

Clare Benson / Wesley Till
June 1999

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Research and Curriculum Development

"Quality in the making" Primary Design and Technology – A lost cause or everything to play for?

University of Central England, Birmingham

David Barlex – Senior Lecturer, Brunel University. Director, Nuffield Design and Technology

The current situation

Future education cannot ignore technology – this is strongly endorsed in England by the new National Curriculum Orders for design and technology. This statement about design and technology makes clear its unique contribution (1).

"Design and Technology contributes to the school curriculum by preparing young people to cope in a rapidly changing technological world. The subject enables them to understand how to think and intervene creatively to improve that world. It helps pupils to become discriminating users of products, to contribute to their home life, the community and, in due course, it broadens their understanding of industrial production, as they develop systems and make products which enhance the quality of life. Through design and technology, pupils learn to become autonomous, creative, problem solvers both as individuals and in working with others."

However the current situation is complex and it is helpful to see it as a combination of two paradoxes.

Our first paradox

On the one hand, since 1990, we have had a National Curriculum (2) designed for breadth and balance – three core subjects, Mathematics, English and Science and six foundation subjects – history, geography, art, technology (design and technology and information technology), music and physical education. This was not questioned significantly in the Revised National Curriculum (3) of 1995. However, a broad and balanced curriculum is susceptible to the charge of overcrowding.

So, on the other hand, in 1998 we have the Minister for Education announcing that the teaching of the programmes of study for the core subjects plus Information Technology was still compulsory; and while the teaching of the foundation subjects, including design and technology, was still obligatory this need take place only with "due regard for relevant programmes of study" i.e. complete coverage was no longer required. (4)

Our second paradox

On the one hand we have the Parliamentary Under Secretary of State for Standards supporting the idea of teachers as an autonomous body of professionals whose professional judgement is to be respected (5) yet on the other hand the Qualifications and Curriculum Authority (QCA), has produced detailed guidance for literacy (6) and numeracy (7) and schemes of work for other subjects – science, information technology, history, geography and design and technology (8).

In one sense this is useful as it is can be seen as an endorsement of the value of all these subjects. But however good the intentions of this government intervention, the result has been less than helpful in maintaining a broad and balanced curriculum in primary schools.

This is due to two main influences. One is the daily requirement for a literacy hour which when coupled with the requirement of the programme of study for English is taking up so much time that time for non-foundation subjects has become quite severely reduced. This is likely to be exacerbated with the introduction of a numeracy hour next year.

The other influence is that of the statutory tests in mathematics, English and science.

There is some professional disquiet as to the appropriateness of the SATs for finding out pupils' levels of achievement. The picture gathered by a teacher through formative assessment is likely to provide a more reliable view of pupil achievement and also provide clear targets for pupil improvement (9).

However, the performance in these subjects is used by the Standards and Effectiveness Unit at the Department for Education and Employment to place primary schools in a public performance league table (10). Obviously primary school teachers feel under pressure to perform in these areas of the curriculum at the expense of breadth and balance.

It is clear that classroom practice is responding to these paradoxes in a way that is putting pressure on the place of design and technology in the curriculum. Teachers working in isolation will be unlikely to resolve the paradoxes. To resolve these, it is necessary to build a community of good practice that provides the critical mass of teachers necessary for the sustainable growth of design and technology in school practice. It is here that a successful curriculum development project can play an important part, so let me describe the work of the Nuffield Primary Design and Technology Curriculum Development Project.

The Nuffield Primary Design and Technology Curriculum Development Project

One aim of this project is to provide the resources that will enable primary school teachers to become more effective at teaching design and technology. The Project has produced a range of teacher materials (11) which has been trialled in over 60 schools. The materials utilise a simple pedagogic strategy – teach children specific knowledge, understanding and skill through small tasks and then require the children to use this in tackling a big task, usually a designing and making assignment, through which they can develop and demonstrate their design and technology capability. If a child's experience is limited to small tasks then that child will not have the opportunity to become capable. If a child's experience is limited to big tasks the child is likely to be unsuccessful and so become frustrated and disheartened.

The Project has developed this framework for describing this mix of small tasks and a big task that defines all the features necessary for successful teaching.

- Possible outcomes
- Context and purpose
- The big task
- The small tasks
- The stories and language resources
- Learning possibilities in design and technology
- Children's design decisions
- How you might teach this activity
- Resources
- Important vocabulary
- Technical advice
- Learning possibilities in the wider curriculum
- Classroom management
- Assessing the children's work
- Grid showing how each session meets the programme of study for all relevant subjects
- Appendix containing any photocopiable resources.

The Project has gone to considerable lengths to ensure that the trial units are attractive and easy to use. There are illustrations throughout and the use of icons helps teachers get a rapid overview of teaching sessions. You can look for yourselves at the units on display.

Topic	KS1	KS2
Using food	2 units	4 units
Using textiles	5 units	5 units
Using resistant materials and structures	2 units	2 units
Using technology	2 units	5 units
Products and applications	1 unit	6 units

Table 1 Describes the range of units currently available

It is clear that we are a developing a broad and balanced approach to design and technology within the Project.

The findings of independent researchers

In 1997 a small team of researchers, led by Patricia Murphy at the Open University, looked at the teaching of early units and made some recommendations to the Project. Then, in 1998, the same team took a closer look at the teaching of three further units (12). The units scrutinised were as follows.

Roly poly

A task in which KS1 children design and make a simple toy (a roly poly) using mixtures of found materials, paper and card. The toy should provide amusement in both its appearance and the ways it moves. It may be for the children themselves or for other younger children.

This unit had been amended in the light of first phase evaluation. Now the focus of the research was to determine whether the amendments made were effective.

Seeing in the dark

A task in which KS2 children design and make a torch using a mixture of found materials and technical components. The torch should be suitable for use in a particular situation – reading under the bedclothes, signalling, lighting a tent.

Here the focus of the research was to determine the effectiveness of the activity in delivering the science and design and technology learning objectives.

Fabulous flowers

A task in which KS2 children design and make a fabulous artificial flower from a range of materials, card, paper, fabric, art straws, pipe cleaners. Each child's flower would be used in a class display of flowers. The flowers should provide visual stimulus and pleasure.

Here the focus of the research was to look at the extent to which the approach supported and fostered children's design decision making.

Having observed the teaching taking place the researchers presented three complimentary analyses – the materials, the teachers' perspectives and the children's perspectives. This is not the place to present their findings in detail, but the following important key points were presented.

- The effectiveness of the small tasks leading to big task approach
- The need to classify the small tasks into two categories – investigative and exploratory. Both types are important. Investigative small tasks are likely to be useful in helping children acquire particular knowledge, understanding and skill, while exploratory tasks would be particularly useful in helping children develop design ideas. The combination of the learning from these two types of small task would be useful in helping children make design decisions about their design ideas. This is an important development from the idea of a small task as being simply to provide a particular skill
- The importance of pupils being actively encouraged to tackle such tasks in pairs or groups in ways that require them to articulate their understanding to their peers. This improves the quality of the learning and also provides the teacher with considerable evidence of such learning simply by eavesdropping on the conversations
- The importance of providing the means for children to make their thinking and planning explicit so that formative assessment is encouraged and facilitated.

Overall the evaluation concludes as follows:
"The approach of the Nuffield Primary Design and Technology materials welcomed by effective and experienced practitioners suggests that they have a more general contribution to make to primary pedagogy. The Nuffield Foundation in working across its subject provision for this phase could make a very significant contribution to the development of pedagogy beyond 2000."

Children's work

The Project believes that success in design and technology is important for all children and has tried to develop methods that will enable teachers to teach in realistic and manageable ways so that all the children in a class will be able to make progress. So one acid test for the Project will be to show that at the end of a Nuffield activity the teacher has a clear view of what has been learned, the children have each designed and made an item of which they are proud, understand what they have done and can talk about it with some degree of fluency. We have captured one complete class's work and put it in the showcase of the Project's website. (13) . Within this class's work I want to look at two groups of pupils to show how valuable such a range of information can be.

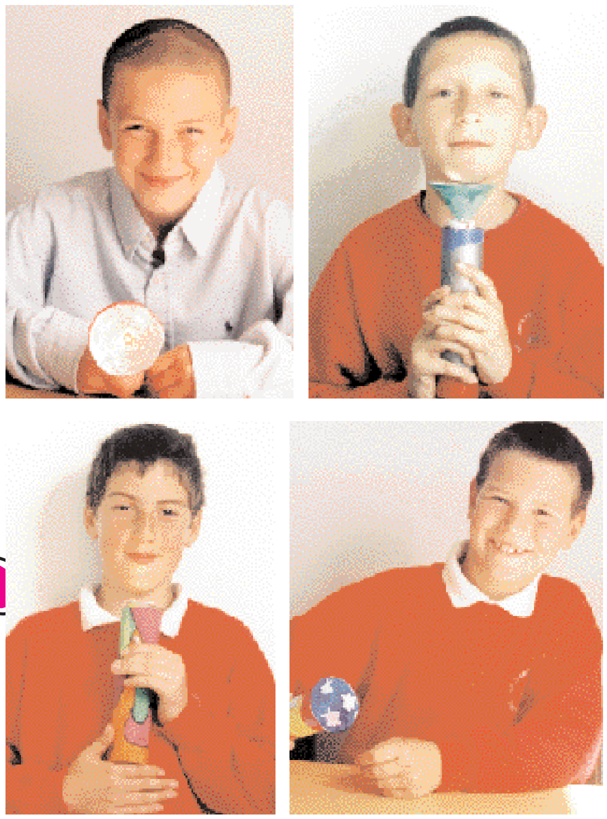


Figure 1 First a sequence of boys talking about their torches. Clockwise from top left – Glen, Peter, Sam and Chris

Glen: "That's how I designed it. That's the Arsenal colours." – limited but strong aesthetic influences.

Peter: "You just press the paperclip down on the paper fastener and then it lights up." – brief technical explanation.

Sam: "My hand is bigger than what the tube is, so I was in frustration – I nearly threw the torch away 'cos I got really annoyed with it because the circuit wouldn't go together and I couldn't really fit my hand in it to get the switch put on the outside. But it came through in the end. (laugh) Em, in the end I actually used, em, the ends of two of my smaller fingers, em, to pull it through, and I had to be really patient and slow." – the importance of patience.

Chris: "I wanted it to be looking like a novelty torch so children would buy it and actually play with it, and because it has got little stars on the top, when you shine it all the stars go light up. So if you are in the dark, like, the stars light up. I used a pressure switch because the one you made up yourself, the one I made didn't go quite right, the paperclips went everywhere, so I just took it off and put on a pressure switch and I had to redesign it because it looked a bit tatty." – much more sophisticated aesthetically, technically and in designing for a user other than himself.

Figure 2 Shows girls talking about their torches. Clockwise from top left – Kirsty and Cheryl, Heather, Jodie, Nicola and Alice

Kirsty and Cheryl: "First of all we got the box, and we turned it inside out, so that you get like the grey sector of the house and then you just like get the …and done this red card roof and stuff and made it like that, and it turned out a house, sort of thing. We designed it to be a house. We wanted it to be a house. We were really pleased with it at the end of the day. We've got Nick out of Back Street Boys and some of the Spice Girls. I went home and cut out of lots of magazines and brought it to school and put it in the back, inside." – clear articulation of pop culture influences.

Heather: "I like making 3D shapes and did the best I can make, and I thought I'll put a bit of light in and it might light up the room a bit. And Loren, she done a blooming triangle and I wanted to be different, so I made it like, em, a diamond shape. If, like the batteries, em, run out quickly, I had to make sure they worked for a long time, made sure they had a lot of energy in, because I didn't want to keep pull it open and closing it again to keep putting the batteries in. Make sure the bulb was in perfect working order so I put it, I had to check the wiring and check the batteries and make sure there were no loose connections, then I taped it in the bottom so that it doesn't all fall around and it was neater." – pleasure in shapes and some conceptual sophistication.

Jodie: "Well my friend helped me because I was away when Mr Perry was talking about how, like, what to do and so my friend helped me by choosing what torch I was going to make. At first I was going to do a mobile phone but in the end I done this one because it was going to be easier. The switch was quite easy to make and, er, I think the circuit was the hardest bit to actually do because I had to do a special circuit because I was using 2 bulbs in it. It went wrong a few times because the connections went wrong inside, so I had to open it up and start again with the circuit which wasn't the right one because the bulbs weren't lighting up bright enough." – technical sophistication and persistence.

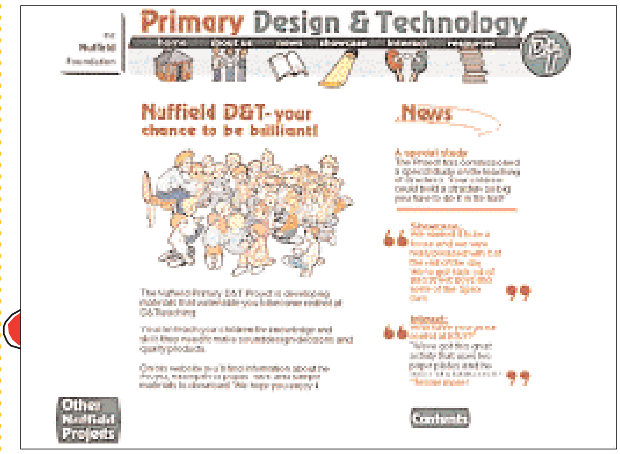
Nicola and Alice: "There is a circuit inside and when you switch it, you pull the tail round, its the switch and it turns a bulb on which acts like a flame that comes out of its month. I enjoyed designing it and working out the ideas for, like, different torches and I enjoyed, em, decorating it and putting on all the finishing touches on so that it looked, em, good. But you had to make sure that the circuit – like all the decisions were right for the circuit, so that it was working properly and we made decisions together on how we wanted it to be decorated and most of it was decided together. The only bit which is a bit different is the tail. We had to change it because the way we wanted it first didn't work. Instead of just having, like, a switch that you turned, we were going to have to connect the end of the tail to the other paperclip so the tail was folded but it didn't light up, so we had to change it." – technical and aesthetic sophistication, persistence in problem solving.

Although this is a limited snapshot it does help to give a sense of the variety of response across the whole class and an indication of the differentiation achieved by the task. For individual teachers who have little experience of, or confidence in, teaching design and technology the showcase will provide extremely powerful professional development. Design and technology co-ordinators will be able to use the showcase as a means of exemplifying good practice and inspiring teachers. Soon the website will have the ability for schools to directly "up load" examples of work to the Project. So at this stage it is important to discuss the website in more depth.

The website

Within the overall aim of providing effective materials, the purpose of the website is to develop and support an on-line community of primary design and technology teachers. The overall structure of the website is described below. The Home page is shown in Figure 3.

Figure 3 Home page of the Nuffield Primary design and technology website



Home

The navigation bar is at the top and features icons as well as words. The page shows an image of a teacher with a class of children (this changes on a random basis between six available images all showing children and teachers) and has live links to News and Resources sections. Note too the presence of a Contents button. This was introduced after discussion with a group of primary teachers revealed that they wanted to be able to see what was on the site "like the contents page in a book". From the Contents page there are live links to all sections of the site.

About us

This contains the following features:

- Listening to teachers (an introduction to the Project)
- Evaluation so far (comments from the first phase of OU research)
- The Structure of an Activity (a description of the way all activities are structured)
- The Nuffield Approach (a description of the approach)
- Contact us (details of contacting the Project by both snail mail and e-mail)
- A Project Schools menu (this allows a viewer to find out if there are any Project schools in a particular geographical region).

News

This is now divided into three sections. Project News describing the latest developments; School News giving details of Nuffield design and technology in action and D&T Newsfeed, being developed to provide the latest information about D&T related to current affairs.

Showcase

This part of the site describes the work of particular Project schools. A key feature is the different routes by which such work may be identified and inspected. A site user may find the work of a school by selecting a region of the UK which will then give a list of the showcase schools in that region. Selecting one of the schools will lead to the school's page containing information about the school (provided by the school) and a listing of the activities carried out at the school. Selecting an activity leads to a description of the activity as carried out by the school (an activity report). If there is a gallery icon present then selecting this will lead to a sequence of screens showing photographs of the children's work. If there is a sound icon present then selecting this will enable the user to hear either teacher or children's comments about the work. The user may also select the name of the activity and this leads to the activity description page that has links to all the showcase schools that have carried out that activity.

Alternatively a site user may select from a menu of categories, related to National Curriculum design and technology. If, for example the user selects Using food this leads to a screen listing the food activities in the showcase – Baking bread and How do you like your toast at the moment. Selecting one of these activities leads to the activity description page that has links to all the showcase schools that have carried out that particular activity.

A site user may also choose to look at a list of all showcase activities simply by selecting underlined text. Alongside this list is the listing of categories so the user can either select a particular activity description or change tack and explore the showcase according to category. As more schools give the Project details of their work this can be added to the database 'behind' the showcase and visitors to the site will be able to find and inspect this work by the same variety of routes. Individual schools are responsible for obtaining parental/guardian permission for photographs and details of children for their work to appear in the Showcase.

Interact

This part of the site is currently under development. There will be three sorts of Forum:

- Open Forums where anyone can take part
- Closed Forums where you need to be registered with the Project to take part
- Special event Forums where you and your children can take part in using state of the art technologies.

Teachers will be able to register for their forum password by e-mailing the Project and giving their school postal address.

Resources

This is the most expanded feature of the site containing the following parts:

- Nuffield Design and Technology materials
  A complete listing of all materials produced by the Project, including some for downloading
- Glossaries
  A listing of important terms in both ICT and design and technology that will grow as teachers let the Project know of additional entries
- Frequently Asked Questions
  A wide range of questions answered, especially chosen for those inexperienced in teaching design and technology
- Teacher Tutorials
  Guidance based on experience from trial schools plus a series of masterclass tutorials written by experts in the field. These are currently under development and will include:
  - Using food
  - Products and applications
  - Working with textiles
  - Understanding structures
  - Applying computers
  - Taking control
  - Handling resistant materials

- Values
- Special Educational Needs
- Cross phase issues
- Problem solving

- Other Resources
  A list of resources from a wide range of other providers including:
  - websites
  - consultants
  - publications
  - literacy
  - numeracy
  - science
  - places to visit
  - suppliers and equipment
  - software
  - TV programmes
  - other curriculum areas
- Acknowledgments
  A listing of those suppliers and others who have helped the Project.

Is the website useful?

The use made of the website is continuously monitored and the Project receives weekly and monthly summaries of data. Table 2 below summarises some features of the use made of the site over the past four months.

Work in Scotland

In Scotland the Scottish Consultative Council on the Curriculum (Scottish CCC) has produced a Statement of Position (14) describing a pedagogical framework for the teaching of technology education. This consisted of the following:

- Creative Practical Tasks
  Large design and make challenges which pupils are to undertake
- Proficiency Tasks
  Smaller knowledge, skill and attitudinal development tasks which contribute to pupils developing technological capability
- Case Study Tasks
  Tasks which explore the broader societal and environmental implications of technological developments.

In surveying the work evolving in other countries it became clear that the Nuffield Foundation, through their Design and Technology Curriculum Project, was supporting and promoting a similar model of technology education to that being encouraged in Scotland. Specifically the Nuffield Foundation curriculum project had developed and was promoting the adoption by primary school teachers of a three stranded approach to teaching and learning:

- Big Tasks
  Equivalent to Creative Practical Tasks
- Small Tasks
  Equivalent to Proficiency Tasks

Months	Average user session length (site sickness)	Average no. of user sessions per day	Number of downloads	Most active countries*
February	11.39	33	427	UK 365, USA 115, Australia 4 New Zealand 3, Canada 3, Cyprus, Denmark, France, Germany, Ireland, Italy, Russian Federation, Spain, South Africa 1 Australia 4
March	8.33	41	147	UK 375, USA 172, Australia 12, Norway 3, Canada, Germany, HongKong, Italy, Netherlands New Zealand. Singapore South Africa 1
April	10.11	58	141	UK 410, USA 190, Australia 19, Canada 8, New Zealand 4, Singapore 4, France 2, Germany, Germany, Ireland, Israel, Italy, Spain, Trinidad & Tobago 1

Table 2 Website statistics

** Note that the country of the user is determined by the suffix of their domain use and that this may not always be an accurate identifier of the actual geographic location of the site visitor*

- Case Study Tasks
  Being developed through literacy materials.

Contact between Scottish CCC and the Nuffield Foundation Design and Technology Curriculum Project has resulted in the development of a joint project. Since late September 1998 19 primary schools have volunteered to become involved. These are located in five Local Authorities across Scotland. They are Aberdeenshire, Glasgow City, Midlothian, North Lanarkshire and Renfrewshire. One other Local Authority, the Borders, has requested involvement, based upon their having seen the planning and reporting tool. Schools recruited reflect the socio-economic diversity, urban, suburban and rural locations and school size to be found generally across Scotland.

The approach adopted in Scotland includes the development of a planning and reporting tool used by project teachers. This allows for a consistent approach to planning and reporting to be used throughout the Project. A project officer provides first hand support. Support is available to project teachers through e-mail, fax and face-to-face sessions. Trialling and feedback recorded in the planning and reporting tool will be used by a small writing team to develop published materials. It is already clear that the planning and reporting tool is proving its usefulness in developing appropriate planning and implementation, and more significantly reflection among the teachers who have used it to date. Teachers who have completed their first scheme report that the pupils are considerably motivated by their experience; that pupil learning and self-esteem are improved; and perhaps most significantly at this early stage of the Project, that teacher confidence is increasing. At least five teachers have reported how much they have enjoyed the teaching, citing the Project's systematic approach to the development of technology education as one of the major contributory factors. The staff and curriculum development outcomes of the Project, coupled to the material products and the proposed dissemination and support strategy, should provide an invaluable resource for the future continued development of technology education in Scottish schools and, incidentally, provide robust examples of good practice to inspire teachers in England and Wales.

Links with the SPACE Project

The second phase evaluation (12) commented:
"the structuring met with approval of both inexperienced and experienced teachers. There is, we would suggest, potential for a similarly structured approach to be considered in the development of other Nuffield Primary materials such as science."

This led to conversations with Derek Bell, the co-ordinator of the Nuffield SPACE (Science Processes And Concept Exploration) Project (15) and it was immediately clear that links between the two projects were both desirable and possible. It is early days yet but the following observations were made.

- The structure developed for design and technology and validated by observing teachers using it may be applicable in developing more structured models of teaching in science
- There are some key concepts which are significant in both science and design and technology and identifying these will be a useful first step to working out means of co-operation
- Exploring areas of understanding in design and technology during KS1 and KS2 as a precursor to developing understanding in science at KS3 was identified as a potentially interesting area of development.

Publication, dissemination and support in England and Wales

The availability of materials by downloading presents an interesting dilemma for a curriculum development project. Traditionally materials have been disseminated in paper based forms by a professional publisher. The Project is in discussion with such a publisher at the moment and the exact mix of traditional as opposed to on-line materials is not yet clear. There is also the issue of how much of the on-line materials should be free of charge. The amount of international use of the site is encouraging particularly the trend observed for the United States, Australia and to some extent Canada – that of a growing community of site visitors. So the potential sales for on-line materials may well be greater than traditional markets. There is also the interesting possibility of the Showcase including examples of children's work from around the world and some of the Forums being international in nature. It is clear that the site has the potential to provide considerable support for primary school teachers wishing to teach design and technology and the early signs are that it is starting to be used.

At the moment the Nuffield Design and Technology Project will pursue a multi-stranded approach to dissemination – newsletters (16), and paper based publication (and within these indicate the availability of the website and its advantages), presentations at conferences and on initial teacher training courses (which will feature the website), in service training in conjunction with local authorities and institutes of higher education (again featuring the website) – all before publication of the final materials; with the expectation that the profile of the website as a means of support for a growing community of good practice in design and technology teaching in primary schools will increase. And it is only by growing this community of good practice that we can reach a situation where teachers, as self determining, autonomous professionals, can take steps to address the paradoxes and resolve the issues facing us at present.

And of course here and now I have a unique opportunity to extend that community and involve you in the way Nuffield develops. On your seat there is a card asking for your ideas for a primary design and technology website. Please fill it in and post it in the Nuffield Primary Design and Technology Post Box on your way out. I will display the results in the foyer on a giant Nuffield post card at the end of today.

References and notes

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  from QCA's Work in Progress to develop the school curriculum
  QCA, London, England
- National Curriculum Council (1989)
  Design and technology for ages 5 to 16
  Department for Education and the Welsh Office, London, England
- School Curriculum and Assessment Authority (1995)
  Design and technology in the National Curriculum
  SCAA, London, England
- The changes were announced by the Minister of Education through a press release and a letter detailing the changes in statutory requirements was sent to all primary schools from the Qualifications and Curriculum Authority.
- Charles Clarke, Parliamentary Under Secretary of State for Standards, has announced the setting up of a General Teaching Council with the following aims:
  – to provide a voice for the teaching profession;
  – to maintain and enhance the profession's high standards; and,
  – to enhance the public standing of teaching.
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Design and Technology for the Millennium – DATA's Vision

The Design and Technology Association (DATA)

16 Wellesbourne House, Walton Road, Wellesbourne, Warwickshire, England. E-mail DATA@dandt.demon.co.uk

Andrew Breckon – Chief Executive of DATA

Introduction

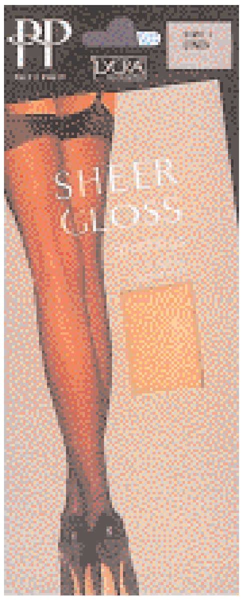
This paper contextualises developments in design and technology in society during the last 100 years. It relates these developments to how and if the school curriculum has been influenced. The paper then looks to the future of design and technology in society and tries to relate this to future developments in the subject. The paper focuses on establishing that design and technology is a powerful educational process and it is an extremely important component of a broad, balanced curriculum. The paper goes on to consider how the modern curriculum has become increasingly politicised. It suggests that design and technology will only have a role in that future curriculum if it can show a relevance to the world of today and tomorrow using new technology and making itself attractive to young people and has real value to our society. The resource implications are considered in terms of training and curriculum time within the context of competing against other curriculum areas. This is particularly the case in primary schools where pressures are immense. The challenge to maintain and develop the position of design and technology in secondary education is also considered, as this will influence the work and status in primary schools. The paper concludes with some thought for a future design and technology curriculum.

Setting the context

There are two ways of providing a vision for the future. One is to analyse the past, draw conclusions on what created change, look for trends and then apply these to future trends. The second is to provide a simple guess. I wish to do the former in this paper, although I cannot be sure that the latter may well be just as accurate. In the paper I will look back at the development of design and technology in society and relate this to education, I will look at how this was formed and then transfer this to future development. I will try to develop a model for design and technology that reflects this modernisation of the subject and then try seeing how this may well be reflected in the curriculum of 2010. Much of what I will be saying will refer to the whole of design and technology education, although I will draw out some specific work in primary. Throughout I will relate to other curriculum and educational pressures that will emerge in order to contextualise the profession's energy and desire for change, a factor that the government's current strategies are beginning to destroy. In my talk I will concentrate on developments in the English education system and I hope you will be able to draw your own parallels or contrasts. My own experience shows there are very significant international trends in education and they are cyclic. On coming to power many governments have attacked the lack of basics in this country over the last century, that was the 3R – Reading, Writing and Arithmetic. After generally failing in these areas they switched to an attack on skills for work. This often has the theme of modernising the future workforce and a third theme which occasionally emerges is internationalism and education's response to this in teaching foreign languages and world history. In this country it is important to recognise that up until 1986 the government made very little impact on what was being taught and the 1988 legislation on the National Curriculum has a clause which presents teaching methodology being set out in the National Curriculum. However the government's national literacy and numeracy strategies for primary schools are certainly very prescriptive, and although not statutory, they are presented in a manner that it is difficult for schools to oppose. Throughout the world governments are giving very high priority to education. However if governments choose to resource such programmes they are likely to wish to be involved, and even if they do not lead the activities, they will give direction to the additional expenditure. In England the government has given £19 billion over the next three years to 'modernise' education, and it has set the priorities for that expenditure.

Context for the development of design and technology

1900 saw the first radio transmission using Morse code, the launch of the Kodak Box Brownie camera and Zeppelin began work on airships. However the 25 years leading up to the turn of the century saw the first refrigerator by Linde (1876), Edison's phonograph (1877) and his light bulb (1879), 1880 saw the linotype typesetting machine, 1890 Levi Strauss produce the first denim jeans, the Diesel Engine by Diesel (1892), the petrol engine by Daimler and Benz (1895). It was a very fertile period of innovation. Many of these products play a key role in our society today more than one hundred years on. It is interesting to note that one of our greatest present day British designers is James Dyson with his Dyson cleaners, but it was in 1901 when Cecil Booth invented the first vacuum cleaner. Where was education at this time? There was no design being taught in the way we know it today, in fact there was little science taught in schools. Most of the learning was through working as pupils to masters who had developed skills and knowledge in the workplace.



The 20th century will probably be known as the age of technology and mass production. In the early part of the century the 'T' Ford (1914), the television by Baird (1926), Dupont develops Nylon (1927), commercial airlines start (1933), the ball point pen by Biro (1938), nuclear power (1945) and the electronic computer (1946)

were all created. In 1950 our education system through the 1944 Butler Act recognised the need for technically skilled young people and the curriculum of our schools was increasing the opportunities for woodwork and home craft (cooking and sewing) and metalwork was introduced to the curriculum. In primary schools there was no coherent structure but art with some craft was emerging. However the craft was most likely to feature basket making.

Since 1950 we have had the hovercraft (1955), video tape recording (1956), satellite (1957), the microchip (1959), man in space (1961), industrial robots (1962), man on the moon (1969) and driving a buggy in 1971, the microprocessor (INTEL) 1971, pocket calculator (1972) and the compact disc, personal computers, mobile phones, swipe and smart cards and software developers such as Microsoft leading to the Internet and integrated communication systems.

In 1999 we have cars which have almost total reliability, aeroplanes travelling twice the speed of sound, we have self-directing cruise missiles, we have microwaves and mobile phones and faxes. We have smart cards and new materials that are light and very strong such as carbon fibre products. We have longlife foodstuffs and ready made meals and a growth in technology that is expedential. World Wars in the first half of the century were great stimulators for technical growth. The 50s and 60s were dominated by the space race to the moon and the end of the century is dominated by communications technology in a wide range of contexts. There were major challenges to how we could manage to feed ourselves, and this has lead to major developments in food production. Many of these developments have been driven by solving problems or meeting challenges those governments, companies or individuals have set. There has been little thought to the environment or the longer-term consequences of such developments to our society.

One of the areas of most significant growth in our society over the century has been our development of marketing to promote a product. This very powerful tool is seductive and encourages us to purchase products. This ranges from buying cigarettes, despite obvious threats to our health, to creating peer-group pressure to purchase 'designer clothes'. The marketing has also brought the designer to the forefront. At the start of the century the term designer was not used, those creating products were 'craftsmen', 'engineers', or 'architects'. Some were called inventors, then we had stylists. Of course design still is poorly understood. The general public still considers design as a styling process 'what it looks like'. Design is frequently related to fashion industry so Paul Smith and Stella McCartney are referred to as designers, whereas Norman Foster and Richard Rogers are referred to as architects. Clive Sinclair and James Dyson are referred as inventors. This all shows the poorly educated society in which we live, having a poor understanding of how to usefully develop technology and how design without full analysis of the consequences is a major danger for the future. It is within this context that design and technology in our education system has grown. The level of ignorance in design and technology must be addressed in the future models for the curriculum, so that we have a society which values such skills, uses them to enrich our society and provides a worthwhile environment for future citizens.

Recent development in design and technology education

The technological and communications revolution has influenced education over the last 40 years. The 1960s to 1980s saw genuine growth in science and technology in our schools and this was particularly apparent in primary education, which wanted more relevance and exciting activities through which learning could take place. Education in this period was increasingly blamed for the failure of British industry and the case for modernising education was very significant. The blame for this failure and other weaknesses was frequently transferred to primary schools. This increasingly led to the view that you need to start everything earlier as that influences young people's attitudes in future life.

In the 1980s the computer was introduced to all our schools, often in the form of a BBC computer, especially in primary schools. This was in its own right a challenge in that some considered we should be using the computer to understand it. Later it was decided that the computer was a tool that will support and enhance learning across the curriculum. The real value may not be as yet ascertained. Some suggest that mobile communications, incorporating computers, will shortly be for many people in a modern society simply the pen and paper tool of the 21st century, able to communicate where and when its user wants, anywhere in the world with access to vast resources at any time. In education the focus will be learning about some specific applications can be used to enrich their learning or to help create 'products' of value. The National Curriculum in 1988 established technology in the school curriculum from 5 to 16. This was a coming of age, recognition of the value, but with very little conceptual understanding, little idea of what it should contain, limited research into methods or progress. The government decided in 1990 to split technology into design and technology and information technology in the National Curriculum. This decision appeared wise in 1989, although the next five years may see the argument for conflation growing. The National Curriculum gave entitlement to all children and created rapid development. Sadly the first five years were marred by impossible aspiration and a lack of common thinking, most specifically in design and technology but also in IT. From 1995 until today the profession has developed a consensus that is genuinely agreed throughout design and technology and there is little disagreement about the way forward.

The concept of 'design' and 'technology' being placed together in our curriculum surprises many curriculum development specialists from overseas. There are three key reasons that give value to combining the two elements:

- Design and designers are about creating products for manufacture, they differ from artists in that designers need to please others, they are briefed, they must be in tune with society's values and in meeting conflicting constraints, and they need to compromise to create an acceptable solution
- Technology is about the application of scientific principles and technological concepts, but technology needs to meet the needs of people, be in tune with society's values and aspirations and meet conflict constraints
- Technology without design, and design without the use of the most appropriate technology, have little sustainable value in today's society.

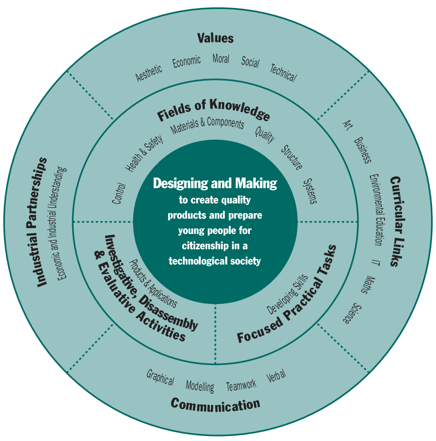
The best new fabric will not impact in our society unless it is used in a sound design. Such principles relate to all areas of product development from food, to building, to medicine. Design and technology has very similar processes and when these are combined and integrated they lead to a well balanced educational experience and this represents the real world in which we live. We must also recognise that design with the application of new technology lies at the heart of any wealth creating society.

Design and technology in our schools today

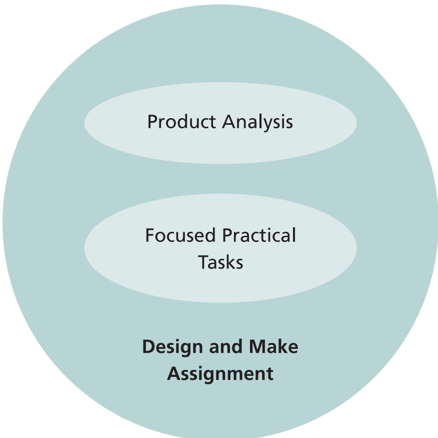
Design and technology in England has been a great success against considerable pressure from traditional educationalists. There is no doubt about the success in either age range; however the subject has hit a plateau. This has been caused by a range of factors:

- The rate of change in technology is almost too quick for the subject to keep up so there is a sense of 'why bother?'
- The government does not invest in genuine curriculum development. It is far too mechanical in understanding design and technology, so because of the need for cuts we have officials removing words like structures and disassembly from the primary National Curriculum requirements. This displays no sense of importance or understanding, more a sense of word count! The level of technical understanding by government officials shows a lack of design and technological understanding. James Gordon in his publication called Structure, subtitled the book 'Why things don't fall down'. This illustrates the fundamental nature of the subject matter and is similar, but not so vital as in English suggesting punctuation is not necessary.
- It has suffered as the government has changed priorities. The decision to relax the National Curriculum requirement in January 1998 for primary, so concentrating on meeting the government's literacy and numeracy targets has already had some impact from less time on design and technology to virtually no time. Few schools are currently spending on resources or training in design and technology
- The design and technology has been keen, especially in secondary education, to bring a degree of stability to the subject. This was very necessary after the first Order but now is a time for change. In DATA's publication on the National Curriculum Review we signalled the need for change and that is being reflected in the new Order
- The economic cycle is not indicating major skill shortages and this government is still confused between ICT and design and technology. Thus the subject does not have high status at this time and there is no major pressure to create new engineers or technologists
- The country now has 242 specialist technology colleges in 109 LEAs as well as 15 city technology colleges and there should be a test bed for taking the subject forward. However this initiative has lost some momentum as the specialist colleges are becoming increasingly focused on helping education action zones EAZs and raising standards in the local community. Although there is evidence of excellence is some technology colleges there has too much emphasis on achieving excellent examination results, with too little emphasis on creating new exciting curricula.

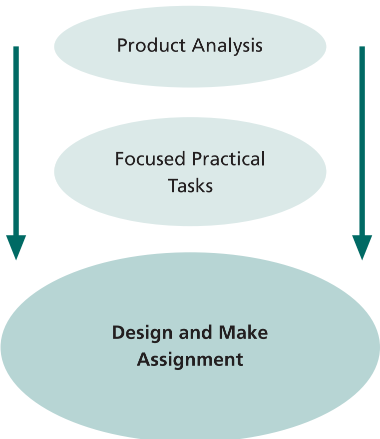
The current curriculum model for design and technology is reflected in the following diagram:



This reflects the central emphasis on design and making products. The full design and technology experience has three activities, investigative, disassembly and evaluating activities, sometimes referred to as IDEAs or product analysis, focused practical tasks (FPTs) and design and make assignments (DMAs). This can be arranged in a sequential form with IDEAs used as a starting point, followed by FPTs which develop the skills and knowledge which leads to a design and make assignment. Equally the IDEAs and FPTs can be within the DMAs.



Product analysis and focused practical tasks within a design and make assignment



Product analysis and focused practical tasks supporting a design and make assignment

The knowledge areas are derived from a traditional basis with materials and components, processes and technique, structures, system and control – both mechanical and electronic. The model provides opportunities for drawing upon knowledge and understanding from other areas inside and outside of school. The creation of curriculum links with other subject areas is a vital feature of design and technology in primary education. The DATA publication Cross-curricular Links within the Primary Curriculum, Research Paper 12 by Rob Johnsey provides excellent information in this area. The current model places emphasis on the values across a wide spectrum of activity and balances this with a wide range of communication skills. This is a sound reflection of the consensus model for design and technology in England. The essence of design and technology is encapsulated by the following statement of intent and objectives.

Design and technology in the school curriculum – Statement of Intent

The key aim of design and technology is to enable pupils to learn how to contribute towards and intervene creatively and constructively to improve the made world in a rapidly changing technological society. It should enable pupils to become discriminating citizens and customers, and to be able to contribute to their home, the community and industry; by having a better understanding of products and their associated values; by using and applying ICT in creative activities; by developing specific technological literacy, understanding and skills; and by fostering the design and manufacturing skills needed to produce quality practical solutions to real problems.

Through design and technology pupils will:

- have their intellectual, innovative and creative abilities stimulated to generate and optimise design proposals
- have opportunities to develop enterprise skills, as well as an understanding of how those who have created products have met the challenge
- integrate and apply technological knowledge and understanding
- develop skills in product analysis and evaluation and combine this with associated values related to social, environmental, spiritual, moral, aesthetic and economic aspects of products and systems
- develop design and thinking skills, including recognition and analysis of need, generating ideas, modelling and planning possible solutions
- use materials, technological components, tools (both hand and computer controlled), techniques and processes to create quality products
- develop the personal qualities needed to complete a design project from initial ideas to finished product
- develop skills in communication, problem solving, application of number and ICT
- work both autonomously and collaboratively with others on design activities.

The current design and technology model with the above statement of intent gives a sound platform upon which to build for the future.

The future of the design and technology curriculum

Science with information technology and design and technology had the political agenda in the last government and this lasted from the 1980s through until the early nineties. The need to readjust the National Curriculum in these areas caused problems and the new government with a priority of Education; Education; and Education had to find new agendas, the emphasis especially in primary schools has changed to literacy and numeracy with ICT also having a priority. The government has set demanding targets for 2002 and once achieved the focus will need to change. On the 26th March 1999 in the TES the Secretary of State gave an indication that he was looking for changes in technology, although the article indicated it was only in Key Stage 4 it is fair to say that this is the start of major changes in the subject. Some argue why and they may well have a point, but this government is intent on modernising education and they are most unlikely to want to keep design and technology as it is, offering a 20th rather than 21st century image to the subject. It is possible to argue that design and technology will be left to drift along and it will naturally die by lack of investment in training and resources.

It is inappropriate to have the excitement of technology and not to use this to provide a quality education. Modern technology demands integration, many companies will argue that you need more investment in designing a product for safe use which is acceptable to the public than is needed to create the technology.

Future possibilities

The technology option

The area of the curriculum may be renamed technology. This makes for a more embracing title in the eyes of some people and enables a new emphasis to be created. This will be very popular as the very large art lobby consider that design lies with art and design and this would help that argument for those wishing to refocus the subject. Such an argument has little value, because technology without design has little or no value. One of the greatest criticisms of our society for the last 100 years has been the quality of our scientific research and our lack of application, equally it has been the lack of the use of designers in engineering. The designer is fundamental to giving high added value to product design. Furthermore with improved conductivity in the next 10 years, one of the new concepts that will underpin the use of the Internet will be citizens who design almost any product they want through the Internet and have it delivered to your home. This will range from clothes, to cars to houses. So although it may appear attractive to dismantle the title that would be very detrimental to our country's future. This is not a case for arguing that design can not be in other subject as well. I would argue that the early part of the 21st Century will be called either the information era or the design era.

The values option

The subject may be refocused to place the emphasis on values issues, especially in helping to address environmental issues in terms of the living environment. This will look at issues in terms of food production, genetic engineering, biotechnology, renewable energy and smart materials and instead of focusing on the designing and making, the focus will be placed on the social, political and environmental aspects of products within our society. This would help develop the analytical skills that help to address the consequences of new technology. In our current climate this technological citizenship is vital to the creation of well-balanced future citizens. There is no doubt any model will need to place much greater emphasis on this area of work.

The ICT option

The subject will I believe be realigned with information and communication technology. The level and rate of realignment is not easy to predict, but there is no doubt the consumer desire for mobile communication means that all the basic information technology functions we currently use such as word processing, spreadsheets and databases will be simplified in operation for ease to a level where they will become second nature to everyone. No different I would suggest to using a television remote controller. The key parts of ICT that will need to be taught are the applications and control of non-screen based functions. Equally designing on screen will be much easier with component databases and the capacity to test designs in virtual reality. This work is highly sophisticated but through robotics and integrated manufacturing more sophisticated work will be capable of being created. This will be a key area for development in schools and one that design and technology must exploit, however this will only be part of design and technology as handling materials will remain an important aspect of the subject. This option could draw in new technological fields such as software engineering and the creation of multimedia presentations.

The systems kit solution

The kit plus software approach with self-assessments on the Internet and remote teachers again may be attractive to some people. This approach uses kits for each topic where the technological principles are taught through structured use of the kits or systems and children can work at their own rate and can use the kit to demonstrate their technological understanding. This is used in some schools now and is seen as an integrated learning system. This approach has value in part, but again the design element is undervalued. Without creating that disciplined experience where a child's capability to design is nurtured then we will fail to develop citizens who are able to make a real contribution to their own lives in a design orientated society.

The design and craft option

This approach is opposed to the ruthless zest for new technology and society's wilful neglect of the environment and natural materials and objects, and with increased leisure time there is the need to develop person craft skills to create and enjoy with a sense of satisfaction the use of such skills and talents. This approach would be welcomed by many traditionalists and may have great value, however I doubt that society would fund such approaches in our compulsory education system.

Conclusions

The options above all have a degree of relevance and also have a degree of danger if they are pursued to the detriment of all the other elements. Design activity will need to be more focused on a range of contexts from personal to the environment, the elements of design that are considered will need to be broader and draw in much more the effects of the design. The design work must have clear defined purposes. There will need to be greater emphasis on teamwork and collaborative projects. The use and application of ICT will be very considerable, but this will not remove the need to work intuitively in a tactile form with a range of common materials. It will be vital that all children experience new materials and learn how they behave, equally the understanding of the use of energy and electricity are fundamental technologies which children need to experience. However there will be no substitute in a lively fast moving society for projects which challenge children, make them think and at the same time are fun. The best form of design and technology for the future in primary schools is enjoyable activities that provide a focus for other learning and pull together discrete elements of the curriculum.

My vision for 2010 is that the headline on the primary curriculum is learning through design and technology.

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'The State of Primary Design and Technology Education in England – Past Successes and Future Developments'

Mike Ive – Her Majesty's Inspector of Schools, England. Subject Adviser for Design and Technology to OFSTED
E-mail mive@ofsted.gtnet.gov.uk

Trends in Design and Technology

Pupils' achievement and progress in design and technology (D&T) in primary schools have improved slowly but steadily since the beginning of the first inspections in 1994. Although they remain more limited than for most other subjects, standards have improved more rapidly since implementation of the revised National Curriculum Order in 1995.

Pupils' making skills are better than their designing skills and both are better than their knowledge and understanding. All have improved but the relative balance remains the same.

Throughout the review period pupils' designing skills have lagged behind their making skills because most teachers are unsure how best to structure development of this aspect of D&T. However, with improving teaching, pupils' designing is getting better. Teachers have increasingly realised the crucial role of discussion in helping pupils to improve their designing skills and that designing is more than just drawing ideas. At Key Stage 1, as pupils discuss their design ideas with each other and with their teacher, they realise the strengths and weaknesses of these ideas and make practical suggestions about how they might proceed. Through the answers to the teachers' questions they show that they have a clearer idea of what they are trying to do, that they understand how materials will function and how tools can be used to adapt them. While they are making and when talking about their finished products they evaluate their work with an increasing understanding of the need to meet a specification – of what the product has got to look like and to do.

At Key Stage 2 pupils are now using an increasing range of strategies, especially where designing skills are good, to establish what they are expected to do. They understand that there is a need which requires a practical solution. They are guided to use interviews, questionnaires, books, magazines and IT systems to find out more about the problem and potential solutions. In the very best lessons pupils plan their work to help ensure they have the time and resources to complete the task on time. By the time they reach the end of Year 6, high attaining pupils use drawings and other modelling techniques to good effect. These pupils also recognise the need to try several potential solutions to see how they work, before deciding on the most suitable proposal. They use sketches with notes alongside to explain their train of thinking and cut-away drawings to explain the inside workings of their products.

A Y6 class was set a design task to work in groups to produce a model car which would travel 2 metres, cost less than £4, and be of attractive appearance. Pupils had to justify their designs against given criteria, produce an invoice for the materials with penalty points for every 10p over £4, as well as design and make the car. They drew on a range of sources for ideas, but there was no direct copying. They used glue guns, drills, rasps, saws, craft-knives, bench hooks and a vice efficiently and accurately; used correct terminology such as 'chassis, aerodynamic, spoiler, body-shell', accurately and with confidence; could discriminate between different woods; made continuous reference to the design brief and were able to comment knowledgeably on design faults brought to their notice by the teacher. (Perdiswell Primary School, Worcester)

Pupils' competence in using materials and components has improved and more now use a wider range than four years ago. The technological use of resistant materials, paper and card has remained better than attainment with mouldable materials, textiles, food or electrical and mechanical components, however. Work with textiles, for example, is often concerned only with aesthetic appearance and not with function. Similarly, whilst most pupils understand how to mix and blend food ingredients and know that cooking changes the taste, texture and appearance of some ingredients, very few know how to improve these characteristics by adding another ingredient, altering the proportions of ingredients, or by using different preparation techniques.

At best, pupils develop their knowledge and understanding during the making activities they encounter. Through good structured teaching, pupils build on their earlier experience and develop an increasing range of techniques so that, for example, they are able to choose when to use different types of glue and when best to use different fasteners such as staples, paper clips, split fasteners and sewing to join paper, card and fabrics successfully.

Some primary schools in North Yorkshire use a 'stickies box' to help develop pupils' knowledge and experience of joining materials. As pupils try out new materials and are taught new methods of joining them – using glue-stick, stapler, paper-clip, stitching or glue gun – a sample of the joined material is added to the box. Later, when pupils are faced with the problem of joining parts together, the teacher refers them to the 'stickies box' so that they can select the most appropriate method from those that they have already encountered, taking into account the materials that they are using and the requirements of the join. As necessary they learn new techniques and add a sample to the box.

Knowledge and understanding of mechanisms and control has steadily improved. More pupils now know how to use simple mechanisms to produce different types of movement and know how to use switched electrical circuits. For example, they often use switches and batteries to provide lights on model vehicles or buildings that they make. Overall, however, even by the end of Key Stage 2 most pupils' levels of knowledge and understanding of structures and of mechanical and electrical components remain low. Similarly, although teachers have increasingly realised the importance of the correct use of technological vocabulary and language, and pupils often take delight in new and unfamiliar specialist words, this is an under-developed aspect of the subject in many schools.

The National Curriculum Order for D&T expects pupils to apply skills, knowledge and understanding from the programmes of study of other subjects, particularly from science, mathematics and art. Initially this occurred infrequently and incidentally. Now planning has improved and pupils make more use of what they have learned in other subjects and make better progress as a result. But this is a two way process; attainment in literacy and numeracy and in various subjects of the curriculum is enhanced as pupils engage is designing and making. For example, in one school pupils' understanding of life in wartime was heightened by analysing gas masks and selecting materials to model their own designs. Measuring, marking and charting skills are often practised and the concept of 'fair testing' is frequently used as pupils select the best material for a particular task. Those pupils who are less interested in reading fiction are often motivated to read non-fiction books to find out about some aspect of their D&T work.

A Year 2 class made products to 'keep Teddy dry' in rainy weather. Pupils discussed the problem as a whole class and then suggested various solutions – coat, boots, hat, umbrella – and what materials would be most suitable. They 'fair-tested' a range of textiles and flexible plastic sheet to see which were waterproof and experimented with each to find out how they might be shaped and joined. By carefully examining their own wet-weather wear they were able to see how each item was made. In groups they evolved their designs for different garments, developing paper patterns and choosing the best joining methods. They made the items before trying them out for fit and considering how they might be improved. The planning decisions, accounts of the work and evaluation of the results were all recorded using discussion, drawings, written notes and an excellent wall-display. The account of this work in the SCAA exemplar material has encouraged other schools to develop their own versions of similar activities. (Torpoint Infants School, Cornwall)

Contributory Factors

When compared with other subjects, there has been a marked improvement in the quality of teaching in D&T lessons: an increase of nearly a half in the proportion of D&T lessons where teaching was judged good and a greater proportionate decrease in the number of lessons where it was judged to be poor.

The majority of teachers found the original Order for D&T problematic: not only was it difficult to understand and open to wide differences in interpretation, but there was insufficient time for teachers to plan the required new approaches. The introduction of the revised National Curriculum for D&T helped schools know what they should teach and was a major factor in the significant improvements in the quality of teaching.

Design and technology is still a comparatively new subject in the primary curriculum, although many of the elements of it were well established. Initially, teachers tended to make the tasks that they set pupils either too prescriptive, little more than a 'craft' experience with pupils making identical products, or excessively open-ended with pupils not equipped with the knowledge and skills required for the design task. As teachers improved their understanding of the objectives of the subject and expectations became clearer, they learned how best to structure the work and pitched the work more appropriately and standards of pupils' work improved markedly.

The presence of an effective subject coordinator in the school is the single factor that has lead to the greatest improvements in teaching in a school. INSET has proved effective in rapidly developing subject coordinators' capability especially when these were extended courses, as with the GEST provision, and when teachers were given support back in their school with the opportunity to share their new experience with their colleagues. All aspects of D&T education improved: staff became more confident; subject knowledge became more secure; schemes of work, progression and lesson planning were more focused; resources were used more efficiently and effectively. In these circumstances teachers soon lost their previous apprehension of D&T and became confident in teaching the subject, often using it effectively to reinforce other learning. Unfortunately only a minority of coordinators were able to attend these courses and current alternative preoccupations are restricting opportunities and progress.

Although most teachers have now gained a basic understanding of the materials, equipment, processes and pedagogy associated with work in D&T, the more demanding aspects of the subject, especially for many of those teaching the older and the more-able pupils, still need attention. Teachers' lack of subject knowledge and expertise remains a constraint to progress in may schools. It is for this reason that the early good progress in Key Stage 1 is not maintained in Key Stage 2 where subject knowledge is more demanding.

The planning of units of work and of lessons has improved markedly although overall planning of schemes of work is less satisfactory. Pupils' designing tends to be better when teachers plan units of work that link together the three types of activity identified in the National curriculum: design and make assignments, focused practical tasks and product analysis when pupils investigate, disassemble and evaluate existing products.

This last activity develops pupils' understanding of why things are as they are and helps them design higher quality products for themselves.

In one school Year 3 pupils were planning to organise a party for 3 year-old children. As part of this task they evaluated drinking vessels that might be used at the party. The teacher had collected 25 different types of cup, mug and beaker and, through questioning, got the pupils to judge the suitability of these for their intended use. Pupils identified the different materials used (glass, china and plastic), commented on the shapes (particularly those aspects affecting stability) and the suitability of decoration. The teacher drew on pupils' previous experience to develop their ideas and knowledge further, ensuring that technical vocabulary (stability, volume, diameter, appearance) and language was used correctly. The pupils worked in pairs to discuss the strengths and weaknesses of the cups and possible modifications that might be made to the samples. In this way pupils were able to develop a suitable simple design specification. Later they went on to design and make cups for themselves, using clay.

Teachers' familiarity with the revised Order, the sharing of experience between schools and the publication of examples of the high quality of work produced in some schools have contributed to much raised expectations of what pupils can do although they remain poor in a quarter of schools. As teachers have become more experienced in the subject they have improved their skills in organising pupils, the range of materials, equipment, other resources and time used more effectively and efficiently. They have also learned to make better use of classroom assistants.

Whereas previously teachers were not sure about asking pupils questions about their ideas, good teachers now often use questioning to good effect, prompting pupils to question for themselves and look at problems afresh. At best, pupils are given responsibility for organising their work, but their plans are frequently questioned and checked by the teacher. Teachers have a clear idea of what pupils are doing, and know when to intervene. When evaluating the products that pupils have made teachers look for and make sure that pupils understand the reasons why some things perform well and others do not. They have a clear grasp of each pupil's attainment.

The Curriculum

Initially pupils' progress was often erratic. Although the reasons vary, it was most often because of weaknesses in long term planning and a failure to build on earlier learning. At the start of the inspection cycle there were few materials available for schools to use to support their planning, especially in those LEAs where there was no specialist advisory support. The exemplar material provided by SCAA and the 'Guidance materials for Key Stages 1 and 2' published by the Design and Technology Association (DATA) provided much needed support and guidance and has led to an improvement in the quality of planning. The latter was purchased by over 15,000 schools, indicating the extent of perceived need. This support has now been expanded by the development of the QCA funded exemplar Scheme of Work which is available free of change to all schools.

Whilst there has been an increase in the use of longer blocks of time for D&T as teachers find this is a more efficient way for pupils to develop D&T competence, the amount of curriculum time given to D&T has dropped slightly over the last four years, especially just recently as schools have given more time to the literacy and numeracy strategies. In the last term it has dropped dramatically.

Overall funding for D&T has not kept pace with the increasing costs of materials and equipment. There have been insufficient monies to extend resources to cover the full expectations of the National Curriculum with a narrower range of skills being developed especially in areas such as control technology, less motivated pupils and constraints on classroom organisation and teaching styles. It has also resulted in some teachers providing their own materials. Small amounts can make a big difference. Pupils in small schools can rapidly developed basic skills as a result of staff development and a modest improvement to the range of equipment and materials.

Similarly, throughout the inspection cycle, in some schools cramped classrooms made it difficult to make effective use of equipment. A lack of sinks, often in temporary classrooms, also restricted the range of materials used. A lack of equipment and appropriate accommodation has meant that pupils had little opportunity to undertake work in food technology.

Issues for the future

The prime issue for the future is the place of D&T in the primary curriculum. It is self-evident that its mandatory place in the National Curriculum has forced many schools, reluctantly, to introduce and develop the subject. The recent emphasis on literacy, and now numeracy, was accompanied by government statements that some subjects, including D&T, could receive less time and emphasis than in the past. We have been told that its former place will be restored. Exactly how all that works out remains to be seen – an outcome of the revision of the National Curriculum currently taking place.

There is considerable scope for improving standards of design and technology in primary schools. Nevertheless, the impact of inservice training has proved effective in promoting the subject in schools, in improving the confidence and skills of teachers, and in raising standards. The first priority for those schools which struggle to provide good quality design and technology should be to increase the subject knowledge of the teachers, particularly the coordinator. Beyond this, there are three further areas for development which would help improve standards. Schools should:

- Ensure that design and technology work is progressively more demanding, building on pupils' previous experience by collecting and analysing samples of pupils' designing and making work from each year group;
- Develop and make the most of the specialist expertise that coordinators and other teachers already have, by pooling knowledge and sharing ideas;
- Ensure that pupils have access to an adequate range of materials and tools when they are designing and making.

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The Ishango Science Clubs: Innovation in Curriculum and Pedagogical Practice

African-Caribbean Network for Science & Technology, Ishango House. 447 Chester Road, Old Trafford, Manchester M16 9HA, UK
Telephone +44 161 877 1480. Facsimile +44 161 877 1481. E-mail lizrasekoala@hotmail.com
Elizabeth Rasekoala – Director

Abstract

Black British children of African-Caribbean heritage, as a group, achieve less well academically than all other groups of pupils. This was evident as early as the 1950's, and has continued, in spite of the improved achievements of other ethnic minority groups in Britain. The theories offered in explanation, and the development of ideas by academics and researchers, dating back to the early sixties, have failed to give suitable guidance on causes of 'under-achievement' and strategies to eliminate them. Thus lack of achievement continues to be an educational truism for African-Caribbean pupils.

The African-Caribbean Network for Science & Technology, challenges the generalised framework of Black youth educational under-achievement in Britain, and has set out to assert with evidence, the specific nature of Black educational disadvantage, which is particularly located in the curricular areas of Mathematics & Science. This specific and focused disadvantage, can be overcome, with the very same methodologies, strategies and research, implemented to overcome the now, much improved, specific educational disadvantage of girls/women, which has also been similarly located in these curricular areas.

In this paper the author utilises an analytical framework of positions on 'race' and Science, to set out a range of standpoints underpinning action on 'race' and Science, Mathematics & Technology (SMT): public understanding of SMT; SMT's economic contribution; promote equal opportunity; challenge the culture of SMT; change SMT culture. It examines the assumptions about 'race', particularly with regard to Black people (of African origin or descent), about SMT, and discusses positive actions undertaken in the United Kingdom, flowing from the respective positions. This paper will present the framework and analyse the positive actions in SMT for Blacks, undertaken in the UK, as good practice which is relevant to, and transferable to other countries.

Introduction

Black British children of African-Caribbean heritage, as a group, achieve less well academically than all other groups of pupils. This was evident as early as the 1950's, and has continued, in spite of the improved achievements of other ethnic minority groups in Britain. The theories offered in explanation, and the development of ideas by academics and researchers, dating back to the early sixties, have failed to give suitable guidance on causes of 'under-achievement' and strategies to eliminate them. Thus lack of achievement continues to be an educational truism for African-Caribbean pupils.

Deficit theories of under-achievement

There have been various theories utilised in research frameworks over the decades, all, unfortunately based on deficit models. These have ranged from:

- Location of the problem within the Black child and the home environment (lack of intelligence, low self-esteem, and poor behaviour), problematising the Black child/family
- Racism in mainstream society and in schools, as a causal factor, particularly, the stereotyping of Black pupils by teachers
- Other more recent ethnographic research has involved frameworks with 'poor' quality schools as the cause; analysing the effects of teachers and their responses to pupils, and the reactions of pupils of African-Caribbean heritage, to their experiences in the classroom.

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The paper is arranged in five parts:

- The disadvantage of people of African Heritage in Science, Mathematics & Technology: The Context of the United Kingdom
- Action for Black pupils success in Science, Mathematics & Technology
- A theoretical framework for initiatives in race and Science, Mathematics & Technology

- The framework as a tool for understanding action for Black pupils and Science & Technology
- Conclusion: Beyond the rhetoric of race equality, towards innovation in curriculum and pedagogical reform.

1 The disadvantage of people of African Heritage in Science, Mathematics & Technology: The Context of the United Kingdom

There is a growing global constructivist consensus premised on the arguments that developments in Science, Technology, and Mathematics, and their role in society, have delivered a legacy of unequal access, achievement, and participation, significantly on the key 'social indices' of gender, social class and race.

In Third World countries with a colonial history, an additional major consideration enters the debate on the historic disadvantage of Blacks in Science. The relevance of imported, western -derived theoretical constructs to local communities is being questioned (Jansen, 1990; Fasheh, 1990). Furthermore, such formal systems are seen to be destructive of local communities in that they become disempowering forces.

Within many Third World countries, the constructs and 'social pedagogy' of Science and technology is a facsimile of either those inherited from colonialism or those of the powerful western capitalist countries. In their design and structure very little consideration is given to the developmental needs of the particular country. Further more, given the ravages suffered under colonialism, issues of redress and reconstruction for successful development have not been successfully tackled.

Black pupils in Britain, especially boys, do poorly in school Science and Mathematics. A key factor in this 'under-achievement' has been the disadvantage in terms of access to the empowerment that comes from the 'critical mass' base in the Public Understanding of Science and Technology (PUST). The PUST 'movement' in the UK has historically been dominated and led by the special interest groups of white male middle-class academics, keen to 'spread' the good news story of the benefits of Science to society, and unprepared to accept any challenging alternative perspectives to this 'utopian' model of Science and society.

While the PUST movement in the UK has made impressive progress on the issue of gender equality, largely as a result of the determined efforts of female academics, on the issue of race equality, it's response has been one of subtle but 'politically correct' resistance to change.

It is thus to the world of school Science and Mathematics that we have to turn to, to first of all quantify the extent of the disadvantage of Black pupils in SMT, in Britain, and to also begin the struggle for change.

My initial exploratory research in three English Local Education Authorities (LEA's); Birmingham, Leeds and Northamptonshire indicated that on entry into schools – Baseline (age 4/5), and early on in school- at Key Stage 1 (age 7) assessments in English, Mathematics and Science, African-Caribbean1 pupils achieved comparable success rates with those of white pupils (see Table 1 for Baseline Assessment Results – Birmingham LEA 1994/6 and Table 2 for Key Stage 1 results from 2 English LEA's).

Ethnic Origin	1994 Maths %	1994 English %	1996 Maths %	1996 English %
African / Caribbean	**19.4**	**37.6**	**27.0**	**26.0**
Bangladesh	7.8	19.5	12.5	12
Indian	14.3	24.6	20.0	20.0
Pakistani	5.8	13.9	9.5	12.0
White	20.1	34.0	24.0	23.0

Table 1 Baseline Assessment Results – Birmingham LEA 1994/6. Percentage of Pupils achieving above average

Ethnic Origin	Mathematics %		Science %		English %	
	Northampton	Birmingham	Northampton	Birmingham	Northampton	Birmingham
African / Caribbean	**74**	**76**	**81**	–	**84**	**78**
Bangladesh	43	66	45	–	51	57
Indian	72	82	68	–	68	82
Pakistani	57	64	64	–	57	62
White	80	80	87	–	82	78
Chinese	85	–	92	–	77	–

Table 2 Key Stage 1 Results – Northamptonshire LEA 1995 & Birmingham LEA 1996. Percentage of Pupils attaining Level 2 (minimum standard) and above

Ethnic Origin	Mathematics	Science	English	Boys	Girls
				Gender Differential Average Point Score	
African / Caribbean	**7**	**9.3**	**27.5**	**1.99**	**2.63**
Bangladesh	24.1	20.7	32.3	3.26	3.58
Indian	31.8	28.3	46.5	3.63	3.68
Pakistani	19.2	18	21.4	2.65	2.88
White	35.2	38.9	47.5	3.35	3.66
Chinese	42.9	50	42.9	3.33	4.68

Table 3 GCSE Results – Leeds LEA 1994. Percentage of Pupils attaining A-C grades in Mathematics, Science & English

Ethnic Origin	Baseline Assessment	Key Stage 1	Key Stage 2	GCSE
	(age 4/5	(age 7)	(age 11)	(age 16)
African / Caribbean	**+20**	**+3**	**-2**	**-21**
Bangladesh	-45	-24	-23	-17
Indian	-5	+8	+4	+14
Pakistani	-43	-17	-10	-15
White	+10	+2	+3	+6

Table 4 The Equality Gaps – Birmingham LEA 1995. Percentage difference from LEA average in the 3 Core Subjects: English, Mathematics & Science

However, this comparability was not maintained as pupils progressed through the education system; whereas GCSE (school leaving results at age 16) success rates in English, for African-Caribbean pupils declined, those in Mathematics and Science had collapsed compared with pupils of white and Asian backgrounds (Table 3 and Table 4). Collapse of achievement for African-Caribbeans was especially severe for boys, with a wider gender differential in achievement for African-Caribbean girls and boys than for any other ethnic group (Rasekoala 1997a, 23-24, 1997b, 12-13; 1998, 3-6).

2 Action for Black pupils' success in Science, Mathematics and Technology

The African-Caribbean Network for Science & Technology and the Ishango Science Clubs

The African-Caribbean Network for Science & Technology (The Network) is a national UK-based educational charity set up in May 1995, by Black professionals working in the various fields of Science, Engineering and Technology (SET), to advance the educational achievements and career aspirations of Black youth in these fields, where Blacks are very much under-represented, due to the inequalities of their educational outcomes in mainstream education in Britain.

Objectives of the African-Caribbean Network for Science & Technology

Short Term Objectives:

- To raise the educational achievements of Black youth in Science, Mathematics & Technology
- To raise awareness of the under-representation of Blacks in the fields of Science, Engineering & Technology (SET)
- To enhance the career aspirations of Black youth in the careers opportunities in SET
- To raise the profile of Black professionals in SET, so that they can serve as positive role models to Black youth, and counteract the negative stereotypical expectations of Blacks in these fields and careers, by mainstream society
- To develop effective working partnerships/links with mainstream institutions in the public (LEA s, schools, teachers, etc.), private, and voluntary sectors, so as to mainstream its aims and objectives, in order to maximise impact, benefits and sustainability.

Medium Term Objectives:

- To increase the number of Black students in post-16 Colleges and Universities, undertaking courses in Numerate and SET fields
- To increase the number of Black professionals taking up employment opportunities in SET fields
- To lobby the SET community to undertake race equality issues alongside those of gender equality
- To support the professional development of Black professionals in the fields of SET.

Rationale for the development of The Network

During the 1980's the drive for pedagogical reform to overcome the disadvantage of girls in Mathematics and Science, made significant breakthroughs in the achievement of girls in these subjects. Unfortunately Black youth have not shared in this success, because these reforms did not distinguish gender patterns in these curriculum areas, among different ethnic groups. Mainstream Mathematics and Science education in Britain today, seems to have largely forgotten education for equality, and ignored global education initiatives, just as it dismissed them as irrelevant earlier in the 1980's. There has also been a profound paucity of research to describe and explore the extent of this subject-based disadvantage in Mathematics and Science, by Black pupils.

In the absence of any mainstream initiatives, either by the education, academic, or scientific communities, the African-Caribbean Network for Science & Technology was formed, and its priority task in its first year, was to develop the focused school and community-based strategies, needed to advance the educational achievements and career aspirations of Black youth and adults, at all levels in SET, in Britain, through undertaking a one year quantitative and insightful qualitative national study, of the subject-based disadvantage in Mathematics and Science of Black pupils, at all levels in the education system (Rasekoala, 1998).

Innovative Strategies of the African-Caribbean Network for Science & Technology

With the concrete information gained from this national one year research study, we were then able to conceptualise and devise the following range of strategies, to overcome the specific subject-based under-achievement of Black pupils in Mathematics and Science.

- Targeted Careers Guidance and Industry links for Black youth in school and outside school settings, involving industry visits, presentations and talks by Black professionals in SET
- Short work experience placements in Industry, to expose Black youth to the exciting careers in the fields of SET
- Trips to places/events of Scientific interest, and interactive scientific exhibitions, to make Science fun for, and relevant to, the every day experiences of Black youth
- In-service training for primary and secondary school Mathematics, Science, and Technology Teachers, on strategies for raising the achievement of Black pupils in these subjects
- Community-based After-school tutorial and study support in Mathematics, Science, Technology and other related subjects, to raise levels of academic achievement in these subjects. These are known as the Ishango Science Clubs
- Examination support, involving exam and revision/study skills for the students taking examinations, to enable them to achieve enhanced results
- Mentoring for Black youth, involving Black professionals from the various fields of SET as role models, to raise the aspirations of Black youth in these careers, and to counteract the negative stereotypical expectations of them by teachers and mainstream British society
- Information and advice services for Black parents to enable them to support the educational attainments of their children more effectively.

The Ishango Science Clubs

The Ishango Science Clubs provide tutorial and study educational support for Black pupils, by providing a place where they can come for guidance, help, support, and encouragement, with their learning, during out-of-school hours. This enrichment programme to raise their educational achievements in Mathematics, Science, Technology and other related subjects, also includes homework support, course work and exam revision support, and the development of core skills. Other programmes aimed at motivating young people to learn, such as peer training and mentoring, also take place.

The Ishango Science Clubs are named after the Ishango Bone, a carved bone, over 11,000 years old. This carved bone, discovered at Ishango, on the shore of Lake Edward in Zaire (Congo), indicates early evidence of a calendrical or numeration system, in that part of Africa.

Targets of the Ishango Science Clubs:

- Improved SAT s scores of the pupils in the Ishango Science Clubs, at Key Stages 2 and 3
- The improved grades at GCSE level and beyond, of the participants in the Ishango Science Clubs
- An increase in the number of Black youth taking up and succeeding in Science specialities beyond the core National Curriculum subjects at GCSE level, which will enable them to pursue Science specialities at higher levels
- An increase in the number of Black youth taking up and succeeding in Science & Mathematics at A Level and GNVQ level (post-16)
- An increase in the number of Black youth taking up and succeeding in Science, Mathematics, Engineering, Technology, Medicine and other related subject areas at University and Colleges throughout the UK
- A reduction in the levels of disaffection with mainstream education among the participants in the Ishango Science Clubs
- An increase in the awareness and involvement of Black parents with the educational advancement of their children.

Activities of the Ishango Science Clubs

The core activities of the Ishango Science Clubs include: tutorial support in Science, Mathematics, Technology and other related subjects; Coursework and examination revision support; Educational Trips to places/events of Scientific interest, and to interactive scientific exhibitions; Careers-Industry links, to raise the career aspirations of Black youth in (SET) fields, through industry visits, presentations, and short work experience placements; and Education awareness training and support for Black parents, to enable them to support their children's educational attainment more effectively.

Curriculum & Resources

The Ishango Science Clubs utilise curriculum materials based on the national curriculum, and work to raise the attainment of pupils, to the levels required by the national curriculum at all key stages and attainment targets. The ethos of the Ishango Science Clubs, is very much one of 'mainstreaming', supporting Black pupils' in achieving their mainstream goals as defined by the national curriculum guidelines, so that they can reap the full rewards in schools, of their attendance at the Ishango Science Clubs.

In addition to mainstream national curriculum materials, the Ishango Science Clubs also utilise the following resources as good practice: Multi-cultural Mathematics and Science resources, The Gatsby's Mathematics Enhancement (MEP, developed by the University of Exeter), and Technology Enhancement (TEP) Programmes, the Nuffield Design and Technology resources and curriculum materials for Mathematics & Science, the British Association Young Science investigators (BAYS) resources and materials. These resources and materials extend the curriculum for all pupils, and help to make Mathematics and Science inclusive and fun.

Staff and Teaching Methodology

All the Tutors of the Ishango Science Clubs are qualified Mathematics and Science teachers, many with postgraduate qualifications including Doctorates, in their fields. Most teach in mainstream primary and secondary schools, while some are Lecturers in the FE and HE sectors. They are mainly of ethnic minority backgrounds, and thus provide positive role models for the pupils in the Clubs. The Clubs also provide an opportunity for members of The African-Caribbean Network for Science & Technology, to volunteer their time and skills as mentors, tutors and role models to the young participants.

All Tutors and volunteers of the Ishango Science Clubs, are encouraged and required to adopt a reflective and self-critical teaching ethos, with a pupil-centred and highly interactive teaching style, providing ample opportunity for all pupils to participate in sessions, and to articulate their learning. Particularly for Black pupils who have been disempowered by their mainstream school experience, the teaching methodology in the Ishango Science Clubs, through encouraging pupils to be active participants in their own learning, and enhanced achievement, raises their self-esteem, confidence and motivation levels. These are the prerequisite building blocks for raising the attainment of these pupils.

Involvement of Schools

The local schools (primary, secondary and post-16) are involved in the Ishango Science Clubs, in 3 key aspects: referral of pupils; providing Assessment/feedback to the Clubs, on the performance of their pupils who attend the Clubs; and benefit from the INSET programmes which The African-Caribbean Network for Science & Technology delivers for their Mathematics, Science and Technology teachers, on 'strategies for raising the achievement of Black pupils in Science, Mathematics, & Technology.'

Benefits and successes of the Ishango Science Clubs

Pupil achievement

The early Indications of Success of our innovative strategies have been both quantitative (in Science, Mathematics, and Technology subjects) and qualitative (general): For the students participating in the programmes in Manchester, Birmingham and Liverpool, these have included, raised academic achievement in schools, and in the Ishango Science Clubs; improved grades in school tests and examinations; pupils being moved from lower to higher achieving sets/streams in schools; enhanced confidence and motivation levels in pupils; improved attitude to school and education; enhanced career aspirations; and increased parental involvement in their children's education.

Benefits of the Ishango Science Clubs

The major impact of the Ishango Science Clubs, have been the enhancement of the academic and educational achievement of participants, in terms of their grades at SAT's, GCSE levels, and beyond, and a raising of their career aspirations and levels of personal development. The Ishango Science Clubs have also had a considerable positive impact in reducing levels of disaffection of participants with mainstream education, and have thus reduced levels of exclusion from schools, for these pupils. The provision of an alternative and enhancing environment for Black youth living in areas of social and economic disadvantage reduces levels of antisocial behaviour and engenders the development of socially enhancing skills.

The educational Trips to places/events of scientific interest and to interactive scientific exhibitions, have helped to stimulate the imagination and expand the horizons of the participants, and are intended to 'make science fun'. They have thus reduced the levels of disaffection of participants with school science.

The empowerment and friendships that African-Caribbean youngsters and professionals gain from their interaction through the Mentoring Programmes of the Ishango Science Clubs, and the positive insights developed, have illustrated to youngsters the lifestyle enhancing benefits of high level educational achievements. Black youngsters have also achieved a valuable understanding of individual initiative and integration into working life and society. The Ishango Science Clubs provide an alternative and academically-based support for Black youth, in subject areas that are traditionally seen as 'difficult' and for which there is little extra-curricular support. The considerable amount of support already available to African-Caribbean youngsters in the humanities subjects and sports, unfortunately tends to encourage their over-representation in these limited fields.

The Manchester/Trafford-Ishango Science Club supports 180 students from 8 secondary and 6 primary schools. The Liverpool-Ishango Science Club supports 150 students from 7 secondary schools and 5 post-16 institutions, while the Birmingham-Ishango

Science Club, which has been operational since January 1999, supports 80 pupils thus far, from 5 secondary schools and 6 primary schools.

Developments in other Cities such as Nottingham, Leicester, Sheffield and the London Borough of Southwark, are at an advanced stage, and have been funded by a grant from the Government's Department for Education and Employment (DfEE).

The RESPECT Campaign

The RESPECT Campaign seeks to improve the attainment of Black pupils in Science, Engineering & Technology (SET), by raising both their awareness of SET careers and their aspirations to pursue them. It increases pupil regard for developing numerical, scientific and technological competencies, by exposing them to Black SET practitioners, trainees, materials and activities. The RESPECT Campaign also contributes to the Public Understanding of Science & Technology (PUST), through enthusing the Black community and mainstream in Britain, with its positive images of Blacks in SET. The RESPECT Campaign promotes posters, leaflets, stickers, etc., showcasing 12 Black male and female professionals in the various fields of Science, Engineering & Technology (SET). It was launched before an audience of Headteachers, Mathematics, Science & Technology teachers from all primary and secondary schools in Birmingham, and the community at large. At the launch, I explained the rationale for the RESPECT Campaign as follows:

'My personal experience as a Chemical Engineer, and that of many other Black professionals in Science, Engineering and Technology (SET), in Britain, is one of isolation, invisibility and marginalisation. This failure and inequality in British society, in recognising the contributions of Blacks in SET, is particularly disturbing, in terms of it's impact on the accessibility of Black youth, to Black professional role models in these fields, and their opportunities to thus enhance their aspirations and achievements, beyond the stereotypical and limited confines of careers in the fields of Sports and Music. It places a considerable burden on our youth, because it makes it well nigh impossible for them, to challenge the stereotypical and limited mainstream expectations of them.'

The posters and leaflets of the RESPECT Campaign will be displayed during my presentation at the Conference.

3 A theoretical framework for initiatives in 'race' and Science, Mathematics & Technology

The meta-analysis of The Network's initiatives in enhancing Black pupils achievement and participation in SMT can be distinguished into five positions on 'race' and SMT:

1 Public understanding of SMT
2 SMT's economic contribution
3 Promotion of equality of opportunity
4 Critical analysis of SMT
5 Changing the culture of SMT.

Advocates of (1), Public Understanding of SMT hold that the general population has an incomplete and misleading perception of science as difficult, mysterious and remote from their everyday lives. Initiatives which seek to replace this view with a more favourable disposition towards science include the establishment of science centres and festivals which invite the public to engage with science in an entertaining fashion.

The (2), SMT's economic contribution view holds that Science, Mathematics & Technology are vital to the wealth of the nation. It equates the success of the leading economies to the greater participation in higher education Science, Mathematics & Technology, in countries such as Germany and Japan. Initiatives which promote SMT as opposed to other disciplines, and which link participation in the sciences with vocational advantage arise out of this position.

Each of these positions views science itself as gender-and-ethnicity neutral; by implication, the solution to the problem of the female or Black under-participation in Science, is a deficit on the part of the girls or Black students themselves. The third position, (3), Promotion of equality of opportunity, also views science as culturally neutral but admits that access to science is unequal. Proponents of the 'equal opportunities' position have developed many special events or opportunities to enable girls and women, or in this instance Black pupils, to engage with science without having to compete for space and attention with white male predominance.

The fourth and fifth positions, (4), Critical analysis of SMT and (5), Change SMT culture arise out of a radically different view. Advocates of Critical analysis of SMT perceive the prevailing culture of science not as objective and neutral but as socially constructed and governed by white, male, middle-class values. Women and Black people are excluded or dissuaded from participation. Finally, proponents of position V maintain that SMT will be improved by a renewal of perspective so that science becomes culture inclusive; ethnicity is not seen as a fixed essential category, and Science, Mathematics & Technology are seen as located in social contexts of time and place. With such renewal, the sciences, and the uses to which they are put, will benefit not only women and excluded groups, but existing practitioners of SMT.

The next section argues that all of these positions are to some degree relevant to the current discussion of action to raise Black pupils' achievements in Science, Mathematics & Technology.

4 The framework as a tool for understanding action for Black pupils and Science

The above conceptual framework argues that SMT is not only socially constructed and gendered, but is also culturally constructed as 'not Black'.

Within this framework, The Ishango Science Clubs occupy position 3, enabling an excluded group to gain equal opportunities in Science, with elements of 2, adding to the pool of quality recruits to an economically important sector; and 1, enthusing a body of students with respect to an exciting field of learning. Analogy with position 4 involves proposing a distinctive 'afro-centric' Science. This position argues that there is not only a conclusive case for presenting and highlighting the roots of Science and Mathematics outside Western Europe, but beyond this, to create a pedagogical paradigm for SMT that enables those subjugated by racist educational practices to undo the physical and psychological effects of these oppressive ideologies, by realising their intellectual potential, using appropriate technologies to support their efforts to generate mathematical and scientific knowledge.

Position 5, changing the culture of SMT, has particular relevance to the combination of gender and ethnicity in the instances examined in this paper, of overall exclusion of Black British pupils which bears down upon males more than females. There exists an historic tendency for racist white culture to infantalise Black 'males' who could be regarded with paternalistic benevolence, in an overtly imperialistic setting, as strong and 'faithful' (or at the present day celebrated as athletes) but whose intellectual competence could be seen as more threatening than that of females. Full adult masculinity including its stereotypical attribution of technical competence is therefore denied. The RESPECT Campaign is a direct response to the imperatives of positions 4 and 5, by the African-Caribbean Network for Science & Technology.

An inclusive pedagogy which takes account of the social dimensions of Science and has an open expectation of high achievement in learning by all groups in society, describes the aspirations of the Ishango Science Clubs and The Network's other initiatives, and has the power to make a difference.

5 Conclusion: Beyond the rhetoric of 'race equality', towards innovation in curriculum and pedagogical reform

The journey towards a self-confident constructivism in SMT, needs to begin with the interrogation of how notions such as 'success' or 'achievements' are constructed. We should begin by posing questions such as: 'how has success in Science & Technology come to be constructed in Britain?', and 'how does this construct contribute to what it means to be Black and poor?'.

The challenges on the road to innovation in curriculum and pedagogical reform, on race and education, in Britain have been outlined above. How is the academic and research community, going to be able to tackle this challenge? It seems an awesome and insurmountable challenge, but what alternative is there, having 'wasted' four decades on 'voyeuristic' research on race and education, and empty rhetoric on race equality? The need for change is imperative, given the demographic time-bomb ticking away in the large metropolitan cities in Britain. We know from the 1991 Population Census data, that the biggest growth in the school-age population, over the next twenty years, will disproportionately come from ethnic minority communities, given their current younger age profile, in comparison to mainstream groups.

The African-Caribbean Network for Science & Technology, has committed itself and its membership, to this long, hard journey, because the prize that awaits us at the end, is worth the struggle. It is about the life chances, and futures of our children, in a 21st century, urban, technological society in Britain, and the opportunities for them, to take up their rightful place in this society, the country of their birth. We will work with all those, who share our genuine interest in advancing race equality, and are committed to transforming the educational disadvantage of African-Caribbean youth, in Science, Mathematics and Technology, through 'hands-on', innovative leadership for change.

Notes on Ethnicity

The term 'Black' is used to describe people of African origin/descent. However, in the United Kingdom, a majority of the Black population are people historically from the Caribbean/West Indies, hence the use in the data and elsewhere, of the term, 'African-Caribbean'. The African population is very much smaller, and is rarely classified in ethnic monitoring.

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Preparing to Teach Textiles in the Primary Curriculum

School of Arts and Lifelong Learning, Faculty of Education, UCE, Westbourne Road, Edgbaston, Birmingham, B15 3TN
Elaine Benbow – Senior Lecturer. E-mail elaine.benbow@uce.ac.uk
Chris Cannon – Advisory Teacher (Design Technology), Lancashire County Council, Weld Bank Lane, Chorley, PR7 3NN

Introduction

Textiles is still a major part of the new National Curriculum orders for design and technology and for art and trainee teachers should now prove their competence to teach textiles in their subject area.

Circular 4/98 Teaching: High Status, High Standards (p11) states that students should have 'a secure knowledge of the subject to at least a standard approximating to GCE Advanced level in those aspects of the subject taught at KS1 and KS2'.

This paper explores possible ways of preparing students to teach textiles in the primary school and meet the Initial Teacher Training (ITT) requirements.

Textiles as part of the art and design and design and technology curriculum in secondary schools is ensuring that the supply of students applying for ITT with textiles experience will continue. Art and design is still in the top ten most popular subjects for A level (DFEE figures for 1997/8) and design and technology is growing in popularity.

Course design

Students taking design and technology as a specialist subject will need to demonstrate that they can work within the design and make process using a variety of materials effectively. In textiles this covers understanding and using skills such as pattern cutting, textile construction, colouring techniques, use of ICT and sewing machines and fabric structure. With only 25 hours teaching time allocated to the development of these skills, new strategies need to be devised to ensure that needs are met.

The use of a design and technology profile or audit has become increasingly important for assessing the knowledge, skills and needs of each student. Once these are established tutors can ensure that their programmes meet these needs and target setting for each individual can drive the outcomes.

The 25 hour course at UCE for Year 2 subject specialist students aims to ensure that students can:

- Develop skills in pattern cutting, textile construction, product construction, colouring techniques and use of the sewing machine
- Work within the design and make process
- Understand the purpose and application of textiles and the aesthetic and technical properties of fabrics which affect choice and use

Students are asked to do this by:

- Taking part in all the workshop sessions that introduce specific skills
- Keep a sketch/resource book to demonstrate evidence of exploration and skill development
- Produce a design brief, make a product (in this case a bag) and an evaluation that demonstrates skills, knowledge and understanding have been understood
- Research the use of textiles for a particular purpose.

Students at UCE study two subjects at specialism level and some were following textiles as part of their art as well as design and technology course, setting up interesting debates about the similarities and differences of the area in both subjects.

Meeting the aims

At the start of the course students were given their design brief:

- Design and make a textile bag/container to hold some personal possessions for a particular person/group of people for a particular event/ occasion/function.

The brief was very broad in nature. Individual students had to identify for themselves the possessions, person and event or function for which the container was to be used. This would provide the criteria against which the final product could be evaluated and was important to the success of the design process. The most successful products were those produced by students who had set themselves a very clear brief. They were expected to display the process for the design and make task, showing initial thoughts, testing, modelling, collecting design ideas and samples of pattern cutting or experimentation.

The students had varied experiences of working with textiles. Experiences ranged from those who had studied textiles as part of an A level course in design and technology or art, to those who openly admitted to having difficulties in threading a needle.

To ensure that all the students had the skills and knowledge needed to produce a textile product to meet the design brief, it was important that the taught sessions provided the basic skills and knowledge needed. They were therefore based on a series of focused practical tasks, each being designed to teach a basic skill or to build up students' knowledge and understanding of textiles.

The focused practical tasks included pattern cutting, fastenings, joining fabrics, hand and machine techniques for textile construction and decoration and safe and accurate use of the sewing machine.

The pattern cutting session involved the students in investigating a printed pattern piece, disassembling a textile product and modelling a bag in paper to look at the size and shapes of the

pattern pieces and method of construction. They also investigated a range of bags to look at the ways in which they were fastened then practised the skills of applying fastenings such as buttons, eyelets, toggles etc. to create samples of fastenings.

Another taught session gave the students the opportunity to use a sewing machine, which was a new experience for the majority of the group. This session also made students aware of the health and safety aspects of working with machines, particularly in a workshop environment. Students produced a sampler to demonstrate their practice of hand and machine constructional techniques including tacking stitch, tailor's tacks, running stitch, backstitch, and treating edges by oversewing or blanket stitch. They also produced other samples of seams, hems and stitching to control fullness. They were also encouraged to produce a sample of decorative stitching through which they could explore the possibilities of the stitch e.g. using different threads, ranging the size and direction of the stitch.

To work successfully with any material an understanding of the properties and the uses to which the material can be applied is essential. Throughout the course students were given opportunities to develop their knowledge in this area through discussion, use of video etc. Students were surprised at the range and uses of textiles in industrial practices as textiles tend to be associated with domestic goods and products. Providing students with a list of textile uses for civil engineering, geotextiles, automotive textiles, horticulture, industrial applications, and medical and protective textiles gave some students a starting point for their individual research.

Other activities which built up their knowledge of textile construction included:

- Identifying the construction of fabrics e.g. woven, knitted, weft and warp and felting
- Identifying the elements of a fabric e.g. fibres, weft and warp threads, selvedge and different weaves
- Looking at finishing techniques applied to fabrics
- Identifying and grouping fabrics into natural or made (a video clip showing fleece fabric being made from plastic bottles created surprise and interest).

On a more practical note the students made examples of woven, knitted, felted and fused fabrics. Many of these activities would be immediately transferable to the primary classroom. An art student has recently carried out a project with reception class pupils to make their own individual pieces of felt based on The Waterlillies by Monet. The individual pieces were put together to create a class wallhanging.

The students were also asked to devise a test which could be undertaken with primary school pupils to test the properties of a fabric e.g. to test washability, stain resistance or absorbency. There are some very obvious links with scientific investigations and understanding of materials which can be explored and applied to design and technology textile work. In planning art activities students could be working in a much more creative way but the skills of colouring and decorating fabrics are common to both subjects.

When working with textile colouring techniques better results are achieved when work is based around a theme, colour scheme or simple related images. The students were therefore introduced to the idea of a mood/colour board which is used as a design aid in the textile industry. To give the work a focus which could also be used in the design and make activity, the students were asked to select a theme from a list or suggest something else they would like to develop. They were asked to collect visual materials related to the theme including images, scraps of paper, fabrics and

wools, threads, sweet wrappers, wrapping paper, photographs etc. As part of the final display students showed their mood/colour boards which helped them to develop a design theme.

During the taught sessions the students had the opportunity to work with batik, screen printing, stencils, printing, marking out, using fabric paints, dyes and sticks, paper bag printing and rubbing to create texture. To make stencils they were introduced to a simple CAD/CAM machine which created simple stencils. Again, many of the techniques could be taught in the primary school classroom as part of a structured textile curriculum related to both art and design and technology.

During the course the students were required to undertake some individual research, that had to demonstrate a selected aspect of textile development within a social or historical context. This could focus on process (how something is made), or with a product (illustrative or comparative objects or styles), or researching the properties of textiles and their uses. The students found this difficult as the available information is limited and difficult to access. Some found that the best way to collect information was from manufacturers or the internet. Those who were the most successful with their research had identified a narrow and focused objective.

On completion of the course all students had acquired enough skills to produce a textile bag/container. The uses for the bags were diverse ranging from a holder for pegs to a sectioned container for balloon modelling materials. The function and designs for the bags were varied and interesting. The students, through their own research had increased their knowledge of textiles technology either by studying a process or product. They all had a resource/sketchbook full of practical examples which could form the basis of future work or could be used as teaching aids. Taking into account the levels of knowledge and understanding of textiles with which the students started the course, they all had to work extremely hard to achieve the objectives, especially within a busy ITT course.

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Quality in the making

Faculty of Education, University of Central England, Westbourne Road, Edgbaston, Birmingham B15 3TN, England
E-mail clare.benson@uce.ac.uk
Clare Benson – Director, School of Maths, Science and Technology

Introduction

'Quality in the making' is the theme of this year's conference. Since the late 1980s primary design and technology education has been a growing worldwide development. The value of the subject has been increasingly recognised and the importance of introducing it to young children has been realised. The inclusion of the subject in primary curricula has been carried out using a variety of strategies and there is already a useful body of knowledge, detailing its implementation, on which to draw. This paper seeks to identify what factors have not only aided 'quality in the making' but have hindered its progress and offers some suggestions as to the next steps to take, to carry us forward successfully into the new millennium.

Setting the context

Whilst it is evident that many countries are introducing the subject into the primary curriculum, it is also apparent that the speed and extent to which it happens varies greatly. Certainly there is not one particular factor which accounts for the successful introduction and development nationwide of design and technology but rather there are a variety of factors which combine to make it happen. It can be argued that in England we are one of the very few countries that has successfully implemented the subject throughout the primary age phase. Inspections monitor the progress of the subject and annual reports provide evidence of this. However, there have been initiatives and strategies which have hindered progress and these must be considered if the subject is to continue to be successful in our primary schools. It is hoped that through the identification of these factors, those seeking to implement the subject will be able to reflect on both positive strategies and those which have hindered 'quality in the making'. Three main aspects relating to 'quality in the making' have been identified-those of a national framework, practice in school and support for design and technology. These will be discussed and suggestions put forward as to the next steps to take to ensure that quality continues to be achieved.

A national framework

The introduction of a national policy, a national curriculum document and a national scheme of work have provided a foundation for a common understanding and approach to the development of the subject.

A National Curriculum-policy and document

Any change at a national level is brought about, in part, by Government policy. In England, the introduction of a National Curriculum as a mandate meant that there was a minimum curriculum entitlement for all children. Of course, not every school introduced the subject immediately but there was a constant expectation by school governors, inspectors and advisors that the legal requirements of the National Curriculum should be met and that, where schools failed to meet these, it was the children who were deprived of their right. Not everyone would agree that such legislation is helpful and that change brought about in such a way does not win the hearts and minds of many teachers (Fullan 1989) but it is one way of trying to ensure that all children have access to a broad and balanced curriculum. There are few other countries in the world where such a mandate exists and it appears that in those countries where there is no national coordinated approach to the introduction of the subject, the rate of change is very slow and inconsistent. Therefore children do not have an entitlement and implementation is variable. Countries such as Australia, Canada and USA have state or province initiatives and thus a national approach has not developed to date.

The current document (DfE 1995) has proved to be the most successful. The language is clear, the content manageable, and the structure provides appropriate guidance in order that schools can create their own schemes of work from it. It allows flexibility so that schools can focus on areas which they feel best meets the needs of their children, while providing a balanced experience over the primary age phase.

However, the National Curriculum has not been without problems. The confusing language used in the 1990 document, the possible range of interpretations, the constant revisions and the change in status of the foundation subjects, including design and technology (QCA 1998a) have all created blocks which have hindered the steady, successful implementation of the subject. Most recently, the possible revisions to the National Curriculum have been published (QCA 1999) and a report based on a statement from David Blunkett, Education Minister (Times Educational Supplement, 1999) stated that the six foundation subjects including design and technology must be covered in full from the year 2000. It is to be hoped that this policy, together with minimal changes to the National Curriculum, will enable schools to concentrate on building on their current practice to continue to raise standards.

A national scheme of work

The scheme of work for design and technology at Key Stage 1 and 2 (QCA 1998b) is a national exemplar scheme which breaks down the National Curriculum into Units of Work and indicates how a broad and balanced curriculum can be created throughout a primary school. There are a number of reasons why this will contribute to the raising of standards. Whilst there is still flexibility for teachers to adapt the curriculum to meet the needs of individual children, it does ensure that all children are covering a similar curriculum. Unlike numerous other countries, there are no textbooks from which to plan the children's work, and teachers in England have to create their own long, medium and short term plans. This scheme of work certainly has reduced the time needed for planning and provides an example of good practice against which schools can match and modify their own schemes. At the present time, there are no findings to indicate how many schools have used and/or adopted the scheme, but anecdotal evidence from Local Education Authority meetings (LEA) and discussions with colleagues around the country suggests that this has had a positive impact on schools and that this is reflected in the quality of the schemes of work which are now being developed.

The nature of the subject

Even as the subject was being introduced into primary schools there was ongoing debate about the nature of the subject. Whilst the content was set in the National Curriculum, one of the key issues was the 'process' versus 'product' debate. The notion that the end product was of little importance was given credence by some. It was argued that the process through which the children worked was all important and that the teaching of practical skills and the production of a quality product was relatively unimportant. Others held opposing views, arguing that a quality finished product should be the most important aim. This led to confusion and was less than helpful for the teacher in the classroom who was trying to implement a programme of work. As a consensus emerged, practitioners were able to focus on an agreed way forward, which did include teaching of appropriate skills, knowledge and understanding together with opportunities to use and apply them. This debate may have led, in part, to the slower development of children's design skills as it is easier to concentrate on making skills, which are more easily identified.

Practice in school

Of course, a quality national framework does not ensure that there is quality practice in schools. A number of factors contribute to success including a supportive head, a proactive coordinator, a manageable school scheme of work with effective monitoring and assessment, appropriate teaching and learning, sufficient resources and teachers who have sufficient knowledge and understanding to teach the subject.

A supportive headteacher

For any successful curriculum change to occur, there is much research (Benson 1998, Harland and Kinder 1997) to show what an important part the headteacher plays. If the headteacher shows that he/she values the subject and wants to ensure that all the children have a quality experience, it will have an effect on both staff and children's attitude to the subject.

A proactive coordinator

A coordinator has the responsibility to ensure that the whole staff are made aware of the scheme of work and how design and technology will be monitored and evaluated. By involving the whole staff in discussions and decisions, a whole school approach to the subject begins to emerge and this is crucial if quality outcomes are to be achieved. The coordinator needs to be able to motivate, to be approachable and to inspire confidence. Indeed, Mike Ive (1999) stresses the importance of such a person in school to lead the development of the subject.

Sufficient resources

There has always been much debate about the cost of introducing the subject into the primary curriculum and the Design and Technology Association's annual surveys (DATA 1996a,1997,1998) have provided much useful information. In the 1997/8 survey in the teachers' judgment levels of funding have continued to rise, with more than 50% of schools reporting adequate or better resourcing. This is certainly a positive finding but there is no room for complacency as 48% still feel that learning is restricted because of the level of funding. Many schools are creative in the ways in which they gain resources and utilise links with people connected to the school and local companies to acquire a wide variety of materials and tools.

Teaching and learning

Whilst documentation is important, appropriate teaching and learning methods are critical if the subject is to flourish. Teachers use a variety of teaching and learning strategies to meet the needs of individual children and differing curriculum areas. The introduction of three types of activity for the delivery of design and technology has certainly aided the quality of teaching and learning in the classroom. Investigative, disassembly and evaluative activity (IDEA), focused practical task (FPT) and a design and make assignment (DMA) have provided a framework for the delivery of each unit of work and this has helped teachers to understand that there is a need for some direct teaching of skills and knowledge which can then be applied, when the children carry out an open ended assignment. Evidence of the raising of standards in teaching and learning is found in recent Office for Standards in Education (OFSTED) reports though there are still more concerns at Key Stage 2 than Key Stage 1 (Ive 1999). Particular areas that still need to be addressed include the development of children's designing skills, the more extensive and appropriate use of specific technical vocabulary and the children's knowledge and understanding, particularly of electrical and mechanical control.

Teachers' confidence

In 1990 there were almost no teachers in primary schools who had an understanding of the subject, who had experienced the subject in their own primary school and who had taught the subject previously. No wonder that OFSTED (Ive 1999) reported that one of the hindrances to the implementation of the subject was lack of teachers' confidence in their abilities to teach the subject. It would certainly have been useful to have had at least a year between the publishing of the 1990 document and its implementation in school, to allow time for training teachers.

Support for the implementation of design and technology
Whilst support was initially slow, there have been some initiatives which have had a marked effect in helping to raise standards.

Developing teachers' confidence and understanding of the subject
Teachers' confidence has been raised through two main routes. Firstly, there has been the opportunity to take part in Inservice courses; and secondly the subject has been introduced to Initial Teacher Training courses. Inservice courses have varied in quality, length and geographical distribution. Where courses have been successful there is evidence to show that these have had a positive impact both on individuals and on schools. However, in order for Inservice to be more effective, it should be available across the country and monitored to ensure that standards are maintained.

Over the last ten years there has been no structured national programme for design and technology in Initial Teacher Education. Generalists students' entitlement has varied from 5 hours to 25 hours and more over their course (Benson 1997, Till 1999) whilst specialist students have had an equally varied provision. It has therefore been hard to maintain standards and to ensure that all those leaving teacher training courses are equipped to teach the subject in the primary school.

More recently there have been a number of initiatives which should continue to increase teachers' confidence and understanding. The Teacher Training Agency (TTA) has identified design and technology as an area in need of inservice support and providers were allowed to bid for courses. DATA was one successful bidder and now manages two courses, one at UCE, Birmingham and one at Goldsmiths in London. The Department for Education and Employment (DfEE) has put forward the notion that all those who want to teach design and technology and other foundation subjects unsupported in the classroom need to have achieved a certain level before leaving their place of training (DfEE 1998). DATA has identified a set of standards (DATA 1996b) which indicate in detail what all generalist and specialist students should be able to do. They have to show that they have capability not only in the subject but in their ability to implement it in school. This should go some way to ensuring that all who leave teacher training and claim that they can teach the subject are in fact able to do so.

A National Association

The importance of having a strong national association that can encourage, offer support and, if necessary, fight for the subject area is evident. DATA has been active at all levels during the last ten years. It has constantly given a steer to the development of the subject at Government, Higher Education, Local Education Authority, school and individual teacher levels. It has maintained a national profile through for example its Journal, its National Conference, its primary publications and its lively primary advisory group. It has brought together groups with differing viewpoints and has helped to provide a coherent and cohesive national support structure.

National events

National events help to give a focus for all those involved in the subject, including teachers, inspectors, Government funded organizations and suppliers of materials and equipment. The annual Design and Technology Exhibition held at the National Exhibition Centre, Birmingham, is one such example. Participants from across the country take part in the event and know that they will be able to access information relating to all new initiatives. From next November the Exhibition is to include science. It will be interesting to observe the effect that this has. It is already being suggested that this will detract from design and technology, and that it will not be beneficial for either subject.

Information sharing

Schools need to have on-going support to help them to maintain and develop design and technology. There are so many new initiatives and literature with which schools are bombarded that it is not an easy task to decide what is, and is not, useful. It would be valuable to have a good national 'filter system' which highlights any kind of support which may be useful to schools. DATA, for example, produces a newsletter and is trying to provide a range of useful information on its website (www.data.org.uk) including news of the latest documents and case studies of work in schools. Other useful websites include QCA (www.open.gov.uk/qca/, Nuffield (www.nuffieldfoundation.org/primaryDandT) and CRIPT (www.uce.ac.uk. then education.research.cript) which offer support for all those involved in design and technology education.

Research

As design and technology was a new subject a decade ago, there has been little research on which to draw. Gradually there have been opportunities to address this problem and dissemination of research has been possible through a number of avenues. Proceedings from conferences such as The International Design and Technology Educational Research Conference (IDATER) and the First Primary Design and Technology Conference (1997) and journals such as the DATA Journal and the International Journal for Design and Technology provide a forum through which to disseminate valuable research information. The range of research is now becoming more varied and there are more research students, including those at Goldsmiths and UCE, with a clear focus on design and technology.

Quality in the making-the future

Whilst in England we have moved a long way in the development and implementation of the subject, there is no room for complacency and there remains much to be done.

- It is essential that there is a period of stability in terms of documentation and national initiatives; this is certainly different to a period of inaction. If we are to move forward and build on best practice, the 'big picture' must stay the same. Schools can then concentrate on evaluating and changing their practice, without constantly changing the long term frameworks
- There is still a need for sustained quality Inservice work to support coordinators and classroom teachers
- The structure of different types of activity has helped teachers to structure their work but it has sometimes led to the fragmentation of the whole design and make process. As teachers become more confident, the structure should be less rigid so that both teachers and children see the process as a whole
- Areas for specific development such as designing, including evaluating, the specific use of technical vocabulary and the development of children's knowledge and understanding need to be highlighted and specific strategies used to ensure standards are raised
- The development of the use of IT within design and technology needs to be extended and support given to help schools to move forward
- The development of cross curricular links needs to be addressed in a more organised way. Links with language, mathematics, science, IT and art need to be clearly identified both in teachers' planning and with the children
- With the rapid developments in technology, the possibilities for sharing good practice worldwide through, for example, e mail, video conferencing and the Internet will increase and cost less. Children are already excited by design and technology. Watching others in different countries taking part in projects will only increase their interest
- Useful areas of research need to be identified and focused on. Joint initiatives with colleagues both in this countries and overseas can only enhance our understanding of design and technology and its development. Such work enables all of us to reflect on and evaluate our own practice
  - Once the new curriculum for the year 2000 is in place, we need to ensure that there is continuing discussion and debate, worldwide, relating to the evaluation and evolution of the curriculum in order that the subject develops appropriately for the new millennium.

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Primary School Design and Technology in the Era of Literacy and Numeracy

Department of Primary Education, The Nottingham Trent University, Clifton Hall, Clifton Village, Nottingham, NG11 8NJ

E-mail robert.bowen@ntu.ac.uk

Robert Bowen – Senior Lecturer

Introduction

The pressure on primary schools from Government initiatives such as 'school improvement measures' and 'target setting' (DfEE 1997) is immense. These together with the imperative to 'deliver' the National Literacy Strategy (DfEE 1998) has resulted in a 'squeeze' on the foundation subjects of the national curriculum. The pressure will increase with the Numeracy (DfEE 1988a) developments planned for the next academic year. This paper discusses how a primary school with the assistance of a university based facilitator, is attempting to manage its curriculum planning to ensure design and technology remains an important aspect of children's education within a broad and balanced curriculum. It explores the processes the school has undergone in examining its current practice and develops tentative plans for projection of its curriculum 1999-2002. Central to this planning is the use of an ICT based system to facilitate curriculum planning processes and curriculum documentation. Findings explore the implications for others of the curriculum development process implemented in this school, the place of design and technology in the primary curriculum post 2000 and the implications of ICT use for curriculum planning.

Setting the context

I first worked at Research School (name of people and the school have been changed to ensure anonymity) during the Spring Term of 1993. It is a small primary co-educational school for pupils aged 5 – 11; having four classes spread between infant and junior departments, each class containing children from more than one age group. This work is a development of the action research I have been carrying out over the last six years.

Theoretical Underpinning

The work resides within the genre of 'Collaborative Social Research' (Miles and Huberman 1994: p8) and is focused on the question:

How can the design and technology curriculum be planned effectively within the current educational climate in primary schools?

It is specifically 'practical action research' as defined by Carr and Kemmis (1986):

'In practical action research, outside facilitators form co-operative relationships with practitioners, helping them to articulate their own concerns, plan strategic action for change, monitor the problems and the effects of changes, and reflect on the value and consequences of the changes actually achieved. ...In practical action research, participants monitor their own educational practices with the immediate aim of developing their practical judgement as individuals. Thus, the facilitators role is Socratic: to provide a sounding board against which practitioners may try out ideas and learn more about the reasons for their own action, as well as learning more about the process of self-reflection.' (203)

Carr and Kemmis (1986) describe educational action research in terms of 'A Dialectical View of Rationality' (180). They define 'dialectical' as the process of weighing contradictory ideas systematically by discussion with a view to identifying how conflict may be resolved and change implemented. They regard this process as the one which characterises the relationship between educational theory and practice. They further clarify this notion, stating:

'Action research, being concerned with the improvement of educational practices, understandings and situations, is necessarily based on views of truth and action as socially-constructed and historically-imbedded. First, it is itself an historical process of transforming practices, understandings and situations – it takes place in and through history. Any action research study or project begins with one pattern of practices and understandings in one situation, and ends with another, in which some practices or elements of them are continuous and others are discontinuous (new elements have been added, old ones have been dropped, and transformations have occurred in still others).

…Second, action research involves relating practices and understandings and situations to one another. …The action researcher, …is aiming therefore to move more surely into the future by understanding how her or his practices are socially-constructed and historically imbedded…

Action research is also a deliberately social process. …it engages the action researcher in extending the action research process to involve others in collaborating in all phases of the research process.' (182)

This work accords well with this definition of Action Research. It is building on the established relationship that I have with colleagues in this school

The primary form of data collection has been taped structured interviews and the predominant forms of data analysis are 'case analysis meetings' (Opt. Cit.: 76) and 'dialectics' (Winter 1989)

The Development of Design and Technology Over the last Six Years

At the time of first contact with the school (1993) they had an established statement on the inclusion of technology, which in their view at that time included both Design and Technology and information technology, in the curriculum:

'This (Technology) involves the application of experience and knowledge about design together with an understanding of how a variety of information may be stored and retrieved using calculators and computers. We plan many instances in our project themes for children to realise the need for solutions to problems in everyday situations or environments. Children find this work very stimulating and there are opportunities to work with construction kits, simple woodworking tools and a variety of materials.' (School Prospectus 1992: 14)

The school was very supportive of my actions and were keen to move forward their thinking about design and technology. I had a number of meetings with the head teacher who was interested in gaining insight into my research. Design and technology did take place in most classrooms though it was not, perhaps, as coherently planned as would be ideal.

Initial work saw me acting in the role of class teacher, in terms of both planning and delivering the design and technology curriculum, with the normal class teacher acting as an observer. From this work came initial insight into teaching design and technology and into methods of planning. This form of activity was spread over four years and one of the results was the development of a Policy Statement and associated Schemes of Work and 'Units of Work' (SCAA 1995). Extracts for the policy statement illustrate the changes in thinking about the nature of design and technology and its implications for children's development during this time:

Rationale

Through design and technology children at Research School are developing better understandings about the technological world in which we live. They are acquiring confidence in their ability to design and to make as well as gaining skills and knowledge that will be relevant to them as adults.

Aims

1 To develop children's personal capability to design and make
2 To progress children's understandings of the concepts, skills and knowledge of design and technology
3 To enable children to gain insights into the technological world around them.

Objectives

Through design and technology children will:

1 Develop creative problem solving abilities through the interaction of hand and mind
2 Develop motor skills through performance with tools.
3 Cultivate personal qualities – e.g. persistence, determination, respect for others and their views, a personal value system
4 Respect the values of craftsmanship
5 Accept responsibility for the consequences of decisions
6 Acquire appropriate conceptual knowledge
7 Value knowledge as a tool for the realisation of a design rather than an end in itself
8 Recognise that the possession procedural knowledge is crucial.
9 Establish designing as a life skill
10 Develop a set of skills and appropriate knowledge that enable the maturing of views on the advantages and disadvantages of technological developments.' (1)

The policy, scheme of work and associated units of work were planned to run over a two year cycle and with school based colleagues carrying out a on-going review during the implementation. Key questions addressed by the review are included at Appendix 1.

Re-establishing Formal Contact

I re-established formal research contact at the start of the 1998/99 academic year with a view to continuing our work on the development of the design and technology curriculum. However, it was at this point in time the 'Literacy Hour' developments were causing peak anxiety for primary teachers. The school was committed to design and technology (and the other foundation curriculum subjects) but the pressure on the time to undertake these subject was very high. Changes to the National Curriculum requirements – 'Breadth and Balance' (July 1998) – introduced by David Blunkett (Secretary of State for Education) had confused the status of Foundation subjects.

Other pressures on this primary school, as others, caused by external development were also very demanding, for example, 'Target Setting' and 'School Improvement Measures' (DfEE 1997). Further, this school, being small had additional difficulties. With few teachers (4, plus HT) amongst which to spread the load and at least two age groups in each class complicating the planning and teaching strategies, they were finding it difficult to deal with these extensive demands.

The processes of the Curriculum Development Activity

It was within this context that I began to work. Initially, I worked with the Headteacher in developing the framework for our collaboration. It quickly became clear that I could not just focus on design and technology as the pressures noted above were having whole school curriculum implications. The focus needed to be design and technology within the context of curriculum change. We identified the following:

Key points

1 I should review the design and technology planning with staff

2 Areas to develop were:
– Medium term planning for design and technology within the context of whole school planning
– The possibility of a more integrated approach to the curriculum should be considered
– Planning for differentiation across the two 'Year Groups' in each class.' (Planning Meeting 15 September 1998).

Two case analysis meetings concerned with reviewing the design and technology planning were carried out. This was carried through taped structured interviews and based on the review questions, extended to include points the key points noted above. From a review of the data a number of key issues about the development of the subject emerged and its relationship to other curriculum areas emerged:

1 Staff indicated that the policy was satisfactory and needed no major modification. There was some feeling that it was 'in the background' but that it did underpin the activities
2 The Scheme of work was generally seen as useful but that it contained too much detail to be of use when planning. It was better though of a reference document that laid out the whole of Design and Technology but that a more practical and narrower document (a more functional scheme of work?) should be developed from it. This could be built from the National Schemes of Work
3 The units of work (Unit of Work) were felt to be very useful. However they need further refinement:
– They varied in quality
– The expectation in some of them was too high – finding the time (as designated with the Unit of Work) was problematic
– The format was too complex
– They contained too much detail and content
– There was need to identify the core learning for a Design and Technology activity and possible extension activities related to this core learning
– The relationship between Focused Practical Tasks and the Designing and Making Assignments needed to be considered. How many Focused Practical Tasks are really needed? Do all children need them all?
– The pace of teaching and sequencing of activities needs to be articulated in the Unit of Work
4 A possible narrowing of the subject's expectations to focus on a number of key areas was seen as valuable. This would enable Continuing Professional Development work to be targeted in these areas
5 A more integrated approach was seen an achievable but the nature of the integration needed to be carefully considered to ensure that links were valuable and valid
6 It was suggested that design and technology could be supportive of literacy activities
7 Information and Communications Technology (ICT) links should be considered when this new medium term planning was developed
8 ICT should be used to aid the school to develop the medium term planning in relation to the points listed above
9 Any planning systems developed need to be practical and simple but also effective.' (Review of meetings 6 and 8 October 1998)

Follow in a further case analysis meeting with the Headteacher (11 January 1999) it was decided to focus on the development of an ICT based system for planning Design and Technology. This would be seen as a pilot project to test the viability of ICT based planning systems. If successful, the developed system would be used in other curriculum areas and would, consequently, enable more integrated approach to curriculum planning across the national curriculum subject range.

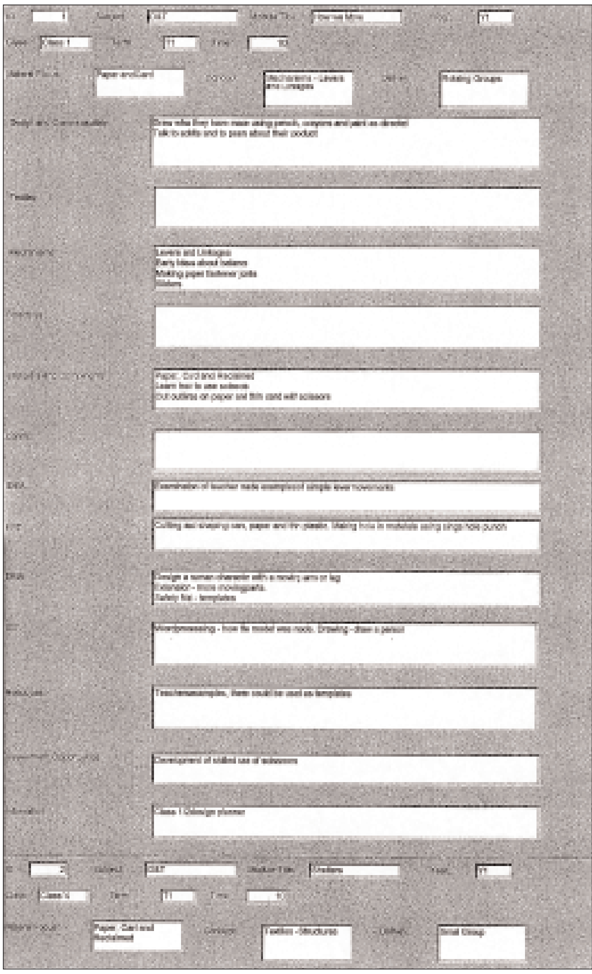


Figure 1

Building on the Current Planning System

The school had mapped out a programme of Design and Technology 'Units of Work' (SCAA 1995) to run over a two year period 1997-99 (see Appendix 2). It was decided that the first stage in the ICT development would be to develop a database that would contain information at this level of planning.

Field	Function
ID	Unit of Work Code – track the number of Units of Work and their kind e.g. Design and Technology 1
Subject	National Curriculum Subject
Module Title	Use to map the curriculum activities
Year	Year of children's in school, e.g. R to Y6
Class	The designation of the class used for internal curriculum organisation
Term	Autumn, Spring and Summer
Material Focus	As defined by the National Curriculum
Concept	The FOCUS concept area(s)
Delivery	Pattern of class organisation, e.g. whole group, rotating groups, etc.
Knowledge Areas	Specific knowledge being addressed through the activity structured under categories defined in the school's policy statement as: • Design and Communication • Textiles • Mechanisms • Structures • Materials and Components
IDEA	Investigative, Disassembly and Evaluative Activities
FPT	Focused Practical Tasks
ICT	How Information and Communication Technology will be used by the teacher and the children
Assessment Opportunities	Related to school policy on assessment and focused on the knowledge and skills refined above
Resources	Specific resources over and above those generally available in the classroom
Information	Any additional information that may be of use, e.g. reference to workshops, books, ICT sources of information, etc

Developing the ICT based System

Microsoft 'Access' was selected as the most appropriate database for this initial development. It is a powerful but flexible ICT tool that enables the development of a 'user friendly' interface. Following the detailed analysis of the taped interviews which reviewed current provision and further case analysis meetings we identified the range of fields to be included (see table opposite).

Working with a university based colleague I developed the database, data entry and data retrieval screens. A limited amount of data was entered from the current Unit of Work and the system demonstrated to staff at the school. Figure 1 shows the data entry screen. It is intended that this will facilitate data entry through the use of facilities such as pull down menus and single keystroke movement between fields.

It should also enable fast and easy modification of Unit of Work planning based on the experience of implementing the plan. The data can be output in a form appropriate for central school records (see Appendix 3 for an example printout). At this stage of the database does little more than could be accomplished by a wordprocessor. However, the development of the system envisages numbers of Unit of Work that are developed over time which would address key aspects of the subject. Once established these would allow searches to be carried out on subject knowledge area, e.g. mechanisms or on level based criteria, e.g. work suitable for Year 3 children, to enable fast and flexible development of medium term plans. Progression of this work is currently underway

Next Stages of Development

The school has been using a paper based system to define the detail of week by week planning (Figure 2)

The next stage of development will be to explore the expansion of the database to incorporate this level of planning.

At the moment only the design and technology database exists and, if this proves effective, the system will be modified and extended to include other curriculum areas. The integration of curricular provision for all subjects at over a period of time (half a term?) is currently still be through the teacher's knowledge of the content in each subject database. Following further development, the use of 'searches' becomes the key to the system facilitating teacher decision making. Once sufficient Units of Work have been entered, to use the power of the system to link planning in design and technology to plans in other curriculum areas becomes a possibility. Future development envisages the ability to undertake keyword searchers through the linked subject databases that would identify possibilities for the teacher to use one of a number of Units of Work that would be appropriate for children in their class and cover the content targeted for a specific period of time. This does not diminish the teacher's role in making decisions about the teaching but will provide fast and efficient access to curriculum plans, that can, of course, be tailored to particular circumstances.

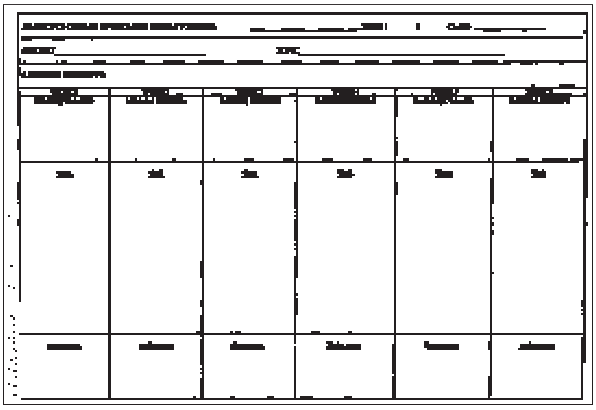


Figure 2

Conclusions and implications for others

The process identified within this paper is one where a research focused activity is used to facilitate curriculum development in a practical and purposeful manner. The interaction between myself as a university based researcher and colleges who are struggling to deal with the realities of implementing national policy has proved beneficial to all.

The development is, as yet, in its early stages. There are a number of issues to be resolved if the system is to prove effective and efficient. As with most development activities there are costs as well as anticipated benefits.

Of concern to colleagues is access to the system; it requires them to be interacting with a computer to undertake the planning. The school does currently does not have a laptop for colleagues to take home neither does each classroom have a PC (each as several computers but these are Archimedes). Will this system prove to be efficient enough to make it worthwhile to use it rather than a piece of paper?

The time cost in initial data entry for the Unit of Work is envisaged as being high. Is this cost justifiable in terms of the long-term advantages noted above?

The system is intended to add flexibility to the planning process, however, it may make planning more rigid if the costs as identified above outweigh the benefits as colleagues probably would not update it. At the time of writing these issues are key to the future progress of the project.

Currently, there are no clear views on the above. The next phase of development will address these concerns and, hopefully, provide a better understanding of how such a system might benefit class teachers.

Appendix 1

Illuminating Primary Design and Technology
Review of Published Policy – 1996-98
Policy, Scheme of Work, Unit of Work Evaluation –
Key Questions – Policy /Scheme of Work

1 Structure
- Is the overall structure of the policy clear?
- What are its strengths
- How could the structure be improved?
- Is the policy structure transferable to your school? How would / does it differ?

The content is structured in two ways – by concept area and by class. Are both needed, which is the most useful?

2 Content
- What issues does the policy content raise for your school
- How does / would your policy differ?
- Should the policy be more closely allied to the National Curriculum by direct reference to the Programme of study

3 Usefulness
- Has evaluating the policy been of any value to you?
- In what ways has it stimulated your thinking?
- In what ways could a document like this be used to help schools develop policy?

4 Additional Comments
- What is needed in this area to help schools?
- Any final comments?

Key Questions – Unit of Work

1 Structure
- Is the planning structure clear
- Is it useful?
- Do the references to other sources of information work?
- Should the reference National Curriculum level descriptions be retained?

2 Content
- Is the level of detail about right?
- Was the level of content right for your class?
- How well did you understand the content described?
- What would have helped you gain a better understanding?

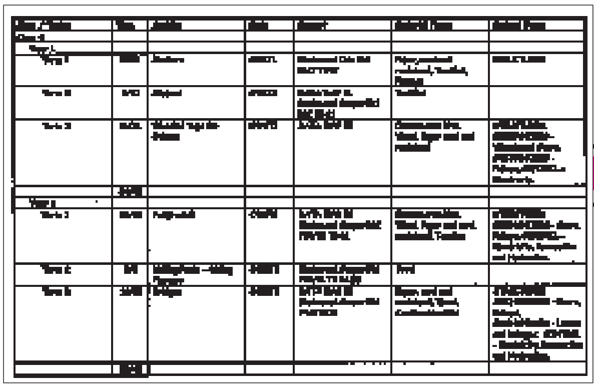
3 Time
- Are the time estimates realistic?
- How long did the activity take when you did it?

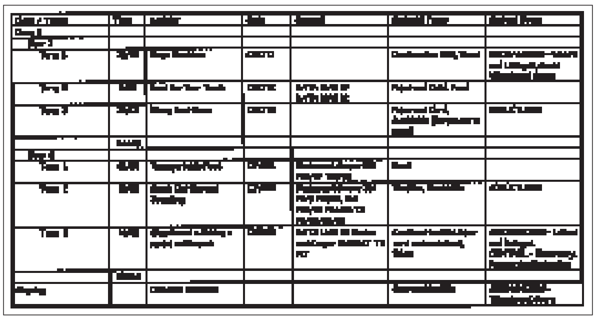
4 Using the Unit of Work
- What additional planning was put in place in order to implement the teaching?
- What other information would have been useful in the Unit of Work?
- Is there any irrelevant information in the Unit of Work?
- Any final comments?

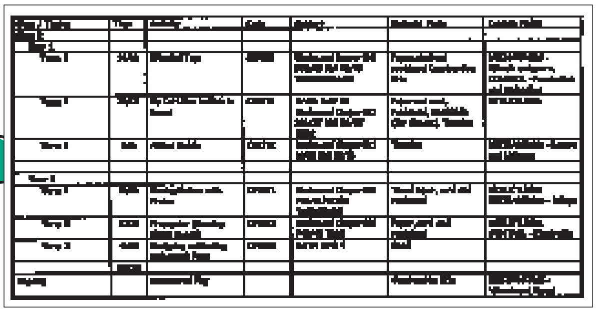
Final Points

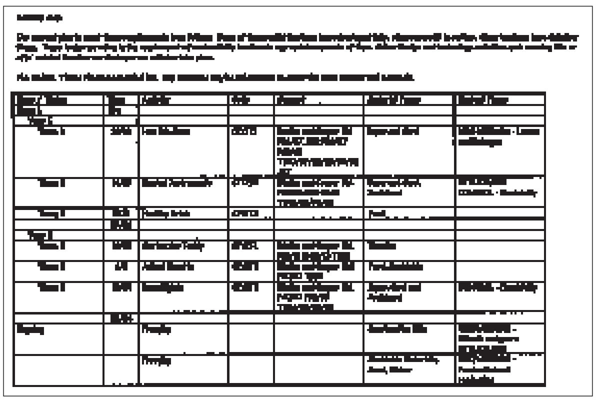
- What do teachers' need to help them plan for design and technology more effectively?
- Any final comments?

Appendix 2

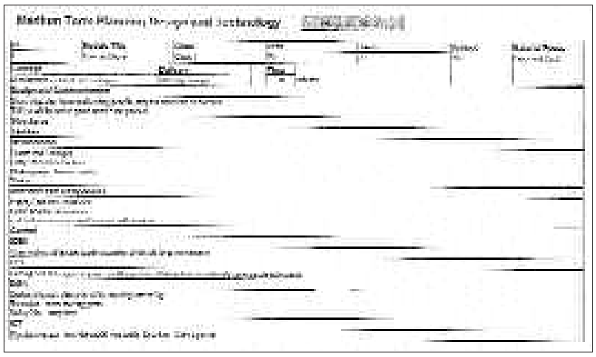








Appendix 3



Medium Term Planning Design and Technology

Medium Term Planning Design and Technology

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From Strength to Strength – Raising the Profile of Design and Technology Within Our School

Springdale Junior School, Warstones Drive, Penn, Wolverhampton, England, WV4 4NJ. Telephone +44 1902 558810

Carolyn Bryan – Design and technology coordinator

Introduction

I took on the role of design and technology co-ordinator at Springdale Junior School in September 1995. At that time design and technology was part of general topic work. The school was trying to move away from this, and put more emphasis on individual subjects. My first task was to develop an outline of a scheme of work in preparation for an OfSTED inspection the following Spring term.

During an audit of the design and technology activities taking place in the school, I found that most technology work fell into three categories:

- *History – The children were involved in constructing models. This was fine for teaching new skills and introducing new materials to the children but did not involve any design input from them.*
- *Board games – These were very similar and showed that there was little progression of skills from lower school to upper school.*
- *Posters – If no other activity could be fitted in then the children made a poster. At this time there was no ICT link to make the most of an activity such as this.*

There was little evidence of any investigating or evaluation of products. There were no food technology activities covered at all.

An audit of resources showed a good collection of tools for wood but very little consumable materials. We also had 12 LEGO Technic kits bought through fund raising but now gathering dust in a cupboard.

The Task Ahead

My headteacher gave me a copy of the School Curriculum and Assessment Authority (SCAA) booklet Design and Technology: the new requirements. This helped me to have a good understanding of what technology was about and how it could be implemented in to the school curriculum more effectively.

We formed a working party with one teacher from each year group to plan the outline of the scheme. The school purchased the Design and Technology Association (DATA) Guidance Materials for Key Stages 1 and 2 and together with the planning advice in the SCAA booklet, we allocated aspects of the National Curriculum Order to each year group. To ensure coverage, balance and progression we tried to ensure that the materials and key areas of knowledge were covered twice throughout KS2, once in lower school and once in upper school.

Working with other year groups in this way ensured that everyone felt they had been consulted and would eventually have ownership of the scheme of work. It also enabled the teachers in the group to develop a better understanding of technology and disseminate this to others in their year groups. One of the outcomes of these meetings was the decision to block technology lessons over several days or afternoons to enable the teachers and children to really get into the task.

First Steps

When the aspects of the Order had been allocated to each year group, suggestions were given as to the design and make assignment for the children some of these were based on the DATA guidance cards. Many year groups took up the suggestions and either used the DATA cards to plan from, or used a blank DATA guidance sheet with the same headings to plan their own activity. This immediately had teachers considering the specific skills they wanted the children to practice, how to introduce the activity and how to structure the design and make assignment with a clear purpose behind it. Many teachers began to collect products for the children to evaluate. The phrases focused practical tasks (FPTs), investigative, disassembly and evaluative activities (IDEAs), and design and make assignment (DMA) were beginning to become more familiar to teachers and helped many to understand what technology was really about.

We went into OfSTED with an outline of a scheme and with work ‘still in progress’. The inspection recognised that we were in the process of developing technology and had highlighted specific areas such as food to target. One very keen teacher in particular had a super display of design and technology work, with photographs showing the children investigating products, practising skills and evaluating their work. This all helped to give us a very favourable comment in the final inspection report.

With technology highlighted as a priority in the School Development Plan I was given the opportunity to attend a funded 10 day design and technology course at The University of Central England (UCE) in Birmingham with other teachers from Wolverhampton. The course gave me the chance to really get to grips with the subject. We went through areas such as structures, mechanisms, electricity, food and textiles enabling us to build up our own knowledge and understanding. The course was very practical and gave us the chance to make teaching aids to help colleagues back at school. One of the most important aspects of the course was planning a scheme of work, which made me realise that our own planning back at school was on the right lines.

I returned to school full of enthusiasm, good ideas, and hoping to inspire others.

A group of Year 3 children proudly showing off their photograph frames

Motivating Staff

I was keen to get other staff as motivated about technology as I was but knowing that teachers have had many changes to cope with I was aware that if the changes I had planned were to be successful, then they would have to be gradual.

During curriculum sessions I asked the whole staff to look at the design and technology they had already planned in their year groups. They highlighted the skills involved and the knowledge and understanding developed by the children against the DATA checklist supplied with the Guidance Materials. I took these sheets away together with comments and suggestions from the meeting and began to formulate them into specific units of work for the final scheme.

My main concern in writing the scheme was that it would be too prescriptive and staff would object to being told what to do. I found exactly the opposite. Everybody was more than willing to try the ideas offered to them.

Rather than throw everything at them at once I presented the units of work to the staff, one term at a time. Where possible the design and make assignment fitted into the topic plan for that term or developed on from science.

When I wrote each unit of work I tried to include:

- IDEAs – I had begun to collect together relevant products for the children to evaluate. In some cases I made teaching aids to help the teacher to explain a particular concept such as cams or levers to the children
- FPTs – I provided a list of books and other resources for the teacher to use and photocopied relevant information sheets covering specific skills where appropriate. I gave the teacher a list of skills that the children should need for the activity and highlighted the skills that would need to be taught
- DMAs – Suggested contexts were given for the introduction of each unit so that the teachers and the children were aware of the purpose of the activity
- Resources – A list of suggested materials was included not only to help the teacher with their planning and organisation but also to help me when ordering new resources.

All these suggestions were welcomed by the teachers concerned and saved them a lot of time in searching for materials for themselves. When I presented the scheme I took time to go

the teacher's attitude towards design and technology. 'We've really had fun' was the comment I was greeted with. By the end of the 2 days I had children knocking on my door to proudly show off their finished products, having been sent by a very proud teacher. She still feels that she is learning alongside the children and is not afraid to admit to them that she is not an expert. She insists on quality from the children, they work co-operatively and they are clear about the skills and knowledge that they are learning. As a result, some of the best design and technology in the school takes place in this teacher's classroom. She is an example to us all.

The future

We were in the second year of our scheme of work when the Qualifications and Curriculum Authority (QCA) scheme came into school. Many of our activities are along similar lines so it was decided to implement any changes gradually over the first year and more fully in the second year. The QCA scheme is well set out and easy for teachers to read and understand. There were no objections from staff to us modifying the design and technology within the school to implement the QCA scheme.

Moving Forward

It has taken us several years to get to this point, and we are still not there yet. With the introduction of the Literacy Hour and the Numeracy strategy many of the foundation subjects have taken a back seat in the school curriculum. However technology is a strength in our school, it offers so much to the curriculum, links with science are the most obvious ones and I am presently trying to highlight as many links to literacy and numeracy as possible so that teachers can save some time. Recently the children designed invitations to the Ugly Bug Ball when they made textile minibeasts. They measured and cut the wood for their picture frames in maths lessons and used a text during Literacy Hour called 'Good things To Eat' produced by The Dairy Council to help with designing their sandwiches. These links not only save time in an already over stretched curriculum but give the children a real purpose to their technology activities.

The constant stream of children knocking on my door on a Friday afternoon to show me their slippers, their mechanical toys, their bags, and offering a taste of their biscuits or sandwiches is a sign of the great pride in the work from both children and teachers alike.

Using basic hand tools to cut square sectioned wood

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The Response of Key Stage 2 children to the Role of ICT in Designing

University of Sunderland, Hammerton Hall, Gray Road, Sunderland, England, SR2 8JB
Telephone +44 191 515 2391. Facsimile +44 191 515 2629. E-mail Carolyn.chalkley@sunderland.ac.uk
Carolyn M Chalkley – Senior Lecturer, School of Education

Introduction

The status of Information and Communications Technology (ICT) within English primary schools has increased over the past decade with an influx of hardware, software and nationally funded initiatives in order to keep pace with the technological change that is imperative for successful performance in the global market. (Smith 1997)

Primary schools are therefore, where the future expertise lies and teachers are required to teach ICT both as a subject in its own right, and as a tool in order to support learning in other subjects. (HMSO 1995)

Primary design and technology (D&T) is one such area that provides opportunities for the use of ICT, most frequently used in terms of routine tasks, such as word processing but to a lesser extent in control exercises and as an alternative to graphic design, despite the application and use of ICT being defined as a 'key skill' within design and technology. (DATA 1999)

This paper attempts to investigate the processes undertaken and strategies used by children when given the opportunity to incorporate the use of the computer within their repertoire of designing methods, especially as an aid to generating ideas and modelling. It begins by reviewing the factors that constrain good design practice in primary schools at this time.

Previous experience suggests that primary age children often disregard the design aspect of projects they undertake, wishing instead to jump straight into the perhaps more exciting making phase. Informal discussions with primary school teachers indicate that this may be due to several factors such as the teacher's lack of understanding of the function of design; constraining factors such as time and facilities; a mismatch between the child's cognitive abilities and the task set; the child's perception of what constitutes 'correct' or 'good' work – the need, in other words, to want to please their teacher and produce a design that is 'right first time', but not necessarily an accurate image of their intent.

The original introduction of the design and technology National Curriculum in 1990 produced a flurry of in-service training for teachers who had little or no experience in terms of providing children with open ended tasks that drew upon their own imagination, creativity and experiences, rather, they provided closed 'creative' activities under the guise of craft which were inherently 'safe' and easy to organise – children generally attempted to emulate the product that had been made previously by the teacher or worked closely to a fixed pattern predetermined by the 'craft' book, resulting in virtually identical displays of work that differed only in the skills based expertise of the participants. There would appear to be, still, despite the introduction of the subject almost 10 years age, a hangover of this practice in some schools and this too would play a part in stifling design creativity.

'Some schools minimise any designing by pupils. They prescribe assignments so closely that the pupils have no opportunities for designing and planning. as a result pupils only have craft experiences, they do not design what they make and all products end up being identical.' (Ive 1997)

Others have adopted the philosophy of designing to some extent, recognising the need for following the design process, but limiting designing activities to 'drawing a picture of what you would like to make', which, come the making phase is readily forgotten about and unlikely to be referred to by the children. Inspection findings have confirmed this view, by recognising that making skills are better developed than designing skills. (Ive 1997).

However, this may in part be due to constraining factors such as time and facilities as it appears to be the case that even where teachers do have an understanding of the processes involved they are unable to provide the children with sufficient time to reflect upon their initial ideas, talk about them and spend time in their modifications, perhaps using modelling materials to experiment and try out ideas first. Often design and technology may be given a notional hour a week and teachers, out of necessity plan their sessions to reflect a linear design process – introduction, design, make, evaluate – so that the whole activity is truncated and curtailed, with evaluation relegated to a 'show and tell' session at the end of the making phase, so there seems to be little discussion and sharing of good practice between pupils and teachers and pupils. The above being the case in the school in which this study is set.

Design and technology enables children to bring about changes in their environment and envisage what may happen in the future and bring about solutions to problems. In order to do this they need to be able to draw upon experiences of themselves and others and be able to imagine possible solutions.(Baynes 1992) These imaginings may outweigh the practical capabilities of the individual and so result in a solution that is less than perfect in the eye of the creator, or the child may find the actual process of thinking of abstract possibilities too daunting a task, therefore relying upon already made solutions or copying the ideas of others. This part of 'designerly development' has been described as a balancing act between cognitive and concrete modelling (Bold 1999). It may therefore be appropriate to assume that it would be possible to use ICT to overcome the need to 'get the drawing right first time' and enable children to experiment and innovate without the fear of 'failure.'

As mentioned previously this paper begins to explore the responses of a small group of year 5 children to a design and make task that was a development from previously undertaken work in which they investigated the properties of strong structures. They had completed a series of focused practical tasks on this. The class teacher had introduced a problem solving exercise related to a National Curriculum history topic on World War 2 whereby they were required to construct a shelter, capable of withstanding air attack.

Participant observation and informal discussions were seen by the researcher to be the most efficient means of gathering information, as the focus of the investigation was to determine pupil response to the introduction of the computer as an aid to their design efforts; would it provide the impetus and enthusiasm to the project that graphically based design failed to do as illustrated by the following discussion with children.

Following a class-teacher led introductory and revision session, reiterating relevant learning outcomes from the previous focused practical tasks, the children split into small groups to begin generating ideas.

Despite fruitful discussion between some individuals within their groups about the way to proceed many appeared to find the task constraining as they already had acquired an image of a typical shelter that would have been used during wartime, during historical research work. The design phase of the project was therefore problematic; the children found the generation of alternative ideas particularly difficult and were basically 'jumping through hoops' possibly to gain approval or finish quickly!

For example, as the following two exchanges illustrate:

- Child A: I've drawn this picture of what I'm going to make… it's like the one I saw in the book… but I can't make it until next week so I'll probably colour this in now.
  Child B: We always have to draw a plan of what we're going to make.
  Researcher (R): Do you use the plan?
  Child B: Sometimes, sometimes I forget. I like making best.
  R: So, if you don't use it why do you need a plan?
  Child B: We always have to do one… the ones that finish quick can make it sometimes
- R: (To a child who had completed one design) Are you going to draw a different design?
  Child C: Mmm… don't think so. Its like the one I've seen. I might have to change it if I can't get any wire.
  R: What is the wire for?
  Child C: To stop the bombs. If there's no wire I might use plastic, that would be strong

Most children discussed the finished appearance of the shelter and material choice, with few appearing to think too deeply about the potential success criteria of their 'strong structure', which had been the class teachers overall aim. For example, one pair produced a rectangular structure that indicated little in the way of support or triangulation

- R: When you have finished this do you think it will stand up on its own? (It wouldn't have done.)
  Child D: I think so… we'll put card triangles on it.
  Child E: Yeah, and it'll be made in wood so it'll be strong.
  R: What shape will the finished shelter be? (It was a rectangle on the plan).
  Child D: It's a square box shape.

From the above sample it appeared that although they had developed some understanding of 'planning' there was little time for reflection and hands on investigation and they were experiencing imaging difficulties in terms of moving between dimensions of their mental image and their graphical capabilities. (Chalkley and Shield 1996)

So would the introduction of a computer aided design package assist the group in their exploration and conceptual understanding of structures by enabling them to overcome their difficulties of drawing by being able to manipulate components to produce a 3D effect?

It might also provide the enthusiasm and impetus to the group to try out different possibilities without the perceived need of 'getting their drawing right' first time.

Observations took place of two groups (children A&B and D&E) who were given the opportunity to re-visit the task and incorporate ICT.

The software was related to the use of a construction kit, the component parts being depicted on screen that could be printed out and adapted whenever necessary. Use of a construction kit before using the chosen materials should allow for quick exploration of shapes and easy fixing of component parts, leading to purposeful enquiry (Bold 1999).

The groups were given time to explore their materials within the kit before the problem was set. This was related to their initial task, so that it could build upon their knowledge of strong structures – but was wider; they were required to construct a shelter that could be used on a desert island, so discussion centred around geographical features and climate – the kit would be used to model the shelters framework, after 'design explorations' had taken place using the software and/or any other method the children chose, such as modelling with the component parts or graphically.

Following task orientation and discussion, choice of 'design methods' was explained to the group. As predicted, using the computer was the popular choice, but little discussion took place regarding the actual model or variety of possibilities. It was more a case of one child (B) commandeering the keyboard and leaving the other group members on the periphery observing the on screen action, but, being non-participatory they soon lost interest and came off task. It could be said that this provided a 'software familiarisation period' as a precursor to later design activities, and after intervention by the researcher and encouragement given to the remainder of the group to participate, the group did begin to make some tentative exploration of on screen possibilities.

However, weak ICT skills were evident (use of mouse, dragging icons to the screen), and imaging problems such as spatial awareness of rotation of their model. Despite several attempts little of value was produced relating to the given task. The attitude of the group shifted around this time with movement away (they required approval to do so) from the computer to the alternative methods of designing that had been explained earlier.

The groups split with 2 children (A&C) reverting to their more conventional way of drawing. At first time was spent trying to depict the construction kits parts exactly, until one child (A) began to talk about what she proposed to do, which was to utilise the features of the island and make a type of 'lean – to'. After the verbal explanation of other solutions to the problem a drawing was produced that seemed to reflect the abstract image of her description. This child's partner (B) was keen to use the kit and began experimenting, eventually producing the side of the shelter that didn't collapse when held upright (drawing upon knowledge of triangulation covered during the focused practical task) and later adding a support for the 'lean-to' effect.

The computer was disregarded by the pair at this point. On task discussion permeated the activity throughout.

Discussions undertaken revealed some interesting responses. Contrary to the notion that the computer would aid designing skills, it could be said that with this group the opposite was true!

When asked about the process they had undertaken, child B's response was the most illuminating.

- R: Did you find the computer useful in helping you to design?
  Child B: Nah… the computer isn't real 'cos we've done it proper.
  R: What do you you mean?
  Child B: Well… you can play with the blocks and see what works… and they help you to draw what you're goin' to make… and the computer is just flat; its hard to see the whole model. And we talked about it. '
  R: Talked about what?
  Child B: The bits we could use to make the model, and what would work the best.
  R: Will you draw a design?
  Child B: Might do when we've made a model that works.

Using the above evidence as a starting point, therefore, it would appear that rather than encourage experimentation during the designing phase of their work, this particular group of children preferred the more 'traditional' methods of design strategies.

It would seem that experiential work using concrete materials provided this group of children with sufficient confidence to explore possible solutions. Discussion also, enabled them to find a way forward. But, the introduction of ICT at this group's stage of design development, seemed beyond their capabilities both practically and conceptually.

Obviously, this research is still in its early stages, but the above emphasises the fact that whilst ICT can provide children with an additional tool for designing, it cannot replace the practical and verbal exploration needed for ideas generation.

Therefore, as conceptual understanding of designing may itself develop, the pedagogical impact of ICT could become clearer as a greater understanding of the potential and creative application of ICT is understood. Linked to this would be an underlying assumption that the professional expertise of the teacher be such that they have a secure understanding of designing and the possible ways that ICT can support such activities rather than be the driving force behind them, simply because a new piece of software is available.

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Which kind of technology is localised and developed in French primary schools?

IUFM – UNIMECA, Technopôle de Château Gombert, 60 rue Joliot Curie, 13453, Marseille Cedex 13

E-mail chatoney@unimeca.univ-mrs.fr

Marjolaine Chatoney – Technology teacher, IUFM Aix-Marseille

Introduction

For French primary schools, the concept of teaching favours the cross-references between the different subjects. Technology activities are gathered in a teaching ensemble with three steps of discovery. The main idea is to build step by step, from 3 years old until 11 years old, the difference between subjects such as technology, sciences, biology, etc. This distinction is not only a question of knowledge but also a question of point of view and methods of investigation. The aim of this paper is to present how this curricular conception induces remarkable biases in the practice of teaching but also in the schoolbooks. Actually technology becomes then, a mean to validate scientific knowledge instead of defining its specificity. I will show here some examples of typology of transposition in schoolbooks and the spontaneous tendency to do more sciences than education of technology.

Setting the context

In primary school activities of technology teaching as defined in the curriculum raises a few problems. French primary schools are organised in three levels, for which the articulation between sciences and technology is deliberately strong. The three levels are 'Discover the world' for pupils from 3 up to 5 years old, 'World discovery' for pupils from 6 up to 8 years old, and 'Sciences and technology' for pupils from 9 up to 11 years old. These organisations highlight concepts and competencies, grouped in a homogeneous block placed side by side. In fact, these juxtapositions of activities and knowledge model the organisation of high school (for 12 years old to 16 years old pupils) where we find separated technology education, biology education, sciences education, and so on.

Technology activities are clearly identified in 'Discover the world' (3 to 5 years old) and 'World discovery' (6 to 8 years old). But the concepts to be acquired in the frame of the activities are not clearly identified in comparison with the methodology of implementation. Later for children of 9 to 11 years old, the activities included in the technology teaching block are combined with scientific activities. The already vague concepts are, at this time, mixed with some identifiable scientific concepts, as electricity or mechanics experimentation.

There is not clearly a technology body of knowledge even though a physics body of knowledge exists. In this context, technology education is reduced to scientific applications or to applied sciences. The value of technology is demonstrated by this. One can see the lowering of status as technology education does not appear with its own cultural attributes, its own knowledge, its own logic and methodology. The applied sciences approach is too restrictive and not a correct representation of technology education. In this case, it is strictly limited to laboratory practices; and these practices are not widely spread as social practices.

The process, by which knowledge is described in the curriculum and knowledge is shown in schoolbooks, follows a specific logic which gives an important role to science knowledge and less status to technology knowledge. My purpose here is to examine this process through the study of the French curriculum, for one part, and through schoolbooks of the five most important editors for the other.

Schoolbook analysis and investigation

The process by which knowledge enters in school situations is well know as the process of didactic transposition (Chevallard, 1985). This theory gives significance to the way that knowledge is transferred from the place where they live to the place they are taught. This process is not simply a transformation or an adaptation of knowledge to the school world but a real rebuilding of specific knowledge which takes place through classroom activities (Johsua, 1998).

The schoolbooks help the teachers to create school activities with a purpose and to define the knowledge they could teach. This transcription is not a neutral context. It induces a particular ideology about, for example, what is technology, science, progress, etc. The schoolbooks' authors plan the activities day to day, throughout the year, with a logic, independent of the real situation.

French teachers of primary schools teach all subjects, so that they could easily manipulate cross-references through the activities they choose. But this advantage is not so good because they could choose their main interest and focus on some subjects and neglect others. In this perspective, a lot of them use some ready-made pedagogic materials when they want to teach science and technology. These materials come through different sources of distribution such as public, private or associative sources.

For technology education, we could find material in terms of descriptions of activities, which go into knowledge and improvement. All these elements give importance to technology education. The schoolbooks are a guide; they could be a model for the teacher. One can understand how the knowledge presented in schoolbooks is relevant for the organisation of school activities, especially in technology education.

We present now a comparative study that deals with teaching modules presented to teachers. We observed the planning of activities, and the recommended teaching methods. We examined also how the five editors take into account technology education. The variables examined are about the sustained ideology of the schoolbooks in relation to technology and the ideas suggested by the activities. We can link these variables with the 'drift away' we can observe. In fact, the personal interpretation and vision of technology education plays a real role in knowledge definitions and could reduce the importance of technology education in French primary schools.

Outcomes of the investigation

Widely, the schoolbooks give an important place to a scientific approach and the pupil is presented as a budding researcher. However much less importance is the place given to technology and the pupil is never considered as a budding designer. Editors favour ready-made deployment of teaching in which the technology method is diluted, and with little substance. In the schoolbooks observed, we could see the following points:

- Technology education appears in only fifty percent of the schoolbooks for science and technology
- In these fifty percent, most of them present technology education as applied sciences without any reference to technology concepts. Only a few present activities with which we could find a strong link with technology knowledge or methods
- The schoolbooks' authors are essentially scientists and we could presume that they are not able to deal with a technology approach and that they confuse this with the scientific approach. This point of view needs to change to provide a meaningful technology education (De Vries, 1996)
- French primary school favours particularly the cross-curricular approach in combination with a subject oriented approach. Through this, we could hope development of general competencies and acquisition of specific knowledge
- The main way to organise cross-curricular activities is based on thematic entry. From this entry, technology education is only viewed as an illustration of the theme.

We could observe the place given to technology education as a caricature of applied science or as an illustration of themes rather then schoolbooks' editors do not neglect it.

Conclusion

This study shows that technology education is more an idea than a reality. We could observe a lack of a definition of a body of knowledge. The lack of status conferred on this subject does not legitimate its place in school; the schoolbooks' editors exclude this subject (Chatoney, 1998). When they take it into account, they rarely submit the necessary tools for its implementation (functional analysis, simple organisation chart and so on).

Technology education is understood as an extension of handicraft and, in fact, does not exist as an identified subject (Ginestié, Andreucci, 1997). A few books conceptualise technology education as a right way of understanding. The design, as a process of elaboration of solution by reducing uncertainty (Lebahar, 1995), is discarded. The functional approach and the links with environment are put to one side (Deforge, 1988). The meeting with actual documents and specific language target is to reinforce traditional experimental models. The hand making becomes the only way that technology education exists and this making is reduced to building some illustration of scientific principles. The validation of the realisation is not a confrontation to the design process but a validation of an experimental trail. Technology education does not exist in French primary schools, except as a vehicle for the application of science.

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Children and Products: An evaluation of some 'IDEAs' tasks

King Alfred's College of Higher Education, Winchester, England S022 4NR. Telephone +44 1962 841515

Bridget A Egan – Senior Lecturer

Introduction

The exploration and evaluation of existing products is an important component of design and technology education in the National Curriculum for England and Wales. Through such tasks, children can be encouraged to develop and to question their perceptions of quality, of fitness for purpose, and of the needs or requirements of end users.

This paper presents an evaluative account of some work using existing products, undertaken with groups of children in a Southampton primary school. In the first part of the paper I present the variety of techniques and approaches that was used, and identify children's responses to them. In the second part, I discuss some of the significance of these responses, particularly in relation to children's understanding of the cultural and social values that are embedded in any product.

Investigating products: Some techniques and responses

The first resource was a collection of kitchen utensils. This is a group of objects that has been collected over time. It includes a number of utensils that are likely to be familiar to children from their home kitchens, and from their own work in food technology. There are also a number of items, which are likely to be less familiar – a whisk that is made from bark-stripped twigs bound together with wire, for instance. This collection was used in a number of ways:

a) Children were invited to play a 'game'. This version of 'Eleusis' was used to draw children's attention to features of some of the products in the collection. I started by choosing a particular criterion, and selecting three or four objects that meet that criterion. I then asked the children in turn to choose another product to add to the set. As each child chose an item, they were told whether it 'went in' the set or not. After each child had had one turn, they had the choice when their turn occurred, of trying to add another item to the set or of telling us what the shared feature of the items in the set might be.

   This approach has the advantage of being very adaptable: criteria can be relatively simple, concerned with materials used ('all have metal in them'), or commonalities of use ('they are all spoons of some sort') or function ('they all have moving parts'); or they can be more complex ('they can all be used for whisking eggs').

   This activity was used with children from a Year 4 class and from a Year 5 class. Both groups needed quite a lot of prompting at first to look at all the objects in a starting set in order to find the feature that they had in common. Their tendency was to choose one item in the set, and then to find another with one feature in common with it. In both groups, the children tended to think first about external, visual features such as colour and general form, or the presence of a particular class of material, and needed to be offered cues to think about more embedded or abstracted features such as use, or the number or combination of materials.

b) A variant of this for younger children was to divide the collection into two sets and ask them to say what the criterion was for including one group of objects in a set and excluding the other group. Once they had grasped the principles of this way of sorting, they were invited to make a set of their own for the others to guess.

This form of the activity was used with children in the Year 2 class. Again, fairly unsurprisingly in view of the responses of the older children, they needed prompting to move beyond the surface features of the objects. Some also found the concept of an inclusion and an exclusion group difficult. They tried to sort the items into groups having one feature or another feature, or to identify 'opposites'. This is something I have observed before in carrying out sorting activities with children of this age.

In addition to the above activities, some children also selected and described individual objects, and some from the Year 5 group drew 'exploded' or disassembled versions of items of their own choice. This latter activity stimulated quite a lot of discussion between the children; they showed great interest in the number of different parts and materials that make up quite (apparently) simple products.

The second resource that I used was a 'mystery object' – a wooden bell from the Far East. This was used with the Year 5 children only. With this, my objective was to encourage the children to use their observational skills as fully as possible. When I had worked with objects previously, I had observed that children were often content to identify them. It had seemed to me that this 'naming' had in some sense prevented the children from looking closely at the object, or from using their other senses to explore it more fully. Questioning sometimes produced rather sterile responses – children seemed to be trying to guess at 'right' answers rather than using their own reasoning skills and observations. I was therefore concerned to find a way of enabling them to work fully with the object. I started by wrapping it in an opaque plastic bag. The children were then progressively asked to make observations, and record what they could find out at each progression. In the first place, they could simply look at the outside of the wrapped object, then feel it through the bag, then feel it inside the bag but without looking at it, and finally to lift it out and look carefully while handling it.

As way of encouraging the children to look more closely at the object than they otherwise might have, I found this activity relatively successful. Most of the children in this group were able to share their perceptions, to listen to each other, and to pay careful attention to their observations of its features. One child, however, found this extremely difficult. From the beginning of the activity, he seemed to understand it as a 'guessing game', and said repeatedly 'I know what it is'. He seemed also to regard the activity as competitive, and interrupted the descriptions of others. He was discouraged when he found that the object did not match his prediction, and needed some help to re-engage with the group activity.

Investigating products: Exploring values issues

All technological activity is a value-laden experience (Layton, 1992 & 1993, Baines, 1995). In investigating these products with children, I was concerned to encourage them to explore not only the technical and instrumental aspects (what they were made of, how constructed, and how to be used) but also some of the values they could be said to embody. Using pairs of objects with the same function, I asked the children why they thought people chose different products to carry out the same activity. With children in the younger age groups, I found this quite difficult to approach. They tended to respond by suggesting that the task was not the same ('you would use this to pick up potatoes and this to pick up peas') or to talk about personal preference ('they would like this one because it's red'). This may of course reflect their unfamiliarity with my teaching style, or that I did not ask the question in a way that they understood. The year 5 children, however, were able to engage with this question much more fully. We sorted out a range of items that can be used to whisk eggs or sauces, including a chopstick, balloon whisks of different sizes made from steel and from cane, the bound twig whisk, a kitchen fork, and a rotary whisk. They were able to discuss aspects such as hygiene and being able to sterilise utensils, the availability of resources for making the objects, recycling and reuse of materials. They also offered explanations for choice based on culture, and on the user's ability to use the items easily (e.g. some needed two hands, some were heavier than others).

In the 'mystery object' exercise, children themselves introduced values issues. They pointed out that the bell was of foreign origin: 'It's not from here' and two correctly identified the region, giving as their reasons for identification aspects of the form, in particular the shape and the carving of the mouth. They saw in the bell resemblances to other objects that they had seen, from India. They noticed that the object was made by hand, and talked about the labour required to make something of that sort by hand. They suggested that the bell might have a religious application.

Yvonne Allison (1997; 1999) has drawn attention to the way in which children, confronted with a range of familiar products may attribute values which are overlaid by prejudice or assumptions (perhaps arrived at as a result of media advertising which targets children). The children with whom she worked found it difficult to apply fair criteria to products such as plastic carrier bags (which carry advertising for the shop from which they come) or crisps. In her studies, brand name and image seemed to be of greater importance to the children than fitness for purpose, the outcomes of blind tasting, or value for money. She suggests that:

- The issue of values needs to be at the forefront of the design and technology curriculum. We need to try and educate children to be intelligent, discerning consumers and intelligent designers and
  …we need to challenge children's thinking and make them increasingly more aware of the factors influencing their value judgements and even our own. (Allison 1999, p31)

I have myself found that when working with familiar products, such as toys, (see advice given in Design and Technology in the National Curriculum, p14, and in Looking at Products and Applications DfEE) children find it difficult to explore values issues. Products specifically aimed at children as owners and users, even if not as purchasers, are likely to carry implications for children's self-image and credibility among their peers. While I endorse Allison's view that children need to be challenged to explore and evaluate the, sometimes very stereotypic and/or intolerant, values that they hold, I think that this is a complex task for the teacher, which needs to approached with great sensitivity.

Other familiar products sometimes provoke a 'naming' response whereby children appear to assume that by identifying the object 'correctly' or by giving single-word answers to questions about its use, they have fulfilled the requirements of the task. Here, the role of unfamiliar products is to provoke questions from the children themselves, which may enable them to expose and to explore some of the values issues which the products embody. In the case of the kitchen collection, the juxtaposition of a variety of tools for doing the same job enabled us to recognise that different users would be likely to have different wants, needs and priorities which were thus not fixed values, and to arrive at a notion of contextual and personal fitness for purpose. Children were able to recognise that for some people it might be more important to have an all-purpose tool than to have specially designed tools for each separate function; or that readily-available and recyclable resources might be more important, in some contexts, than elaborately made or expensive tools.

It particularly interested me that, faced with a completely unfamiliar object from another culture and time, children themselves raised values questions, and offered explanations which were both interested in and tolerant of the values of others. It seems that, with the aspect of personal 'investment' in the product removed, children are more able to explore values and to engage in informed and sensitive thinking. This does not, of course, make a case for suggesting that children should only work with unfamiliar products in Products and Applications work or in IDEAs tasks. It seems to me possible, however, that using explorations, which do include or use the unfamiliar, we may enable children to begin to consider their own values through making tentative suggestions about the values of other people and other communities.

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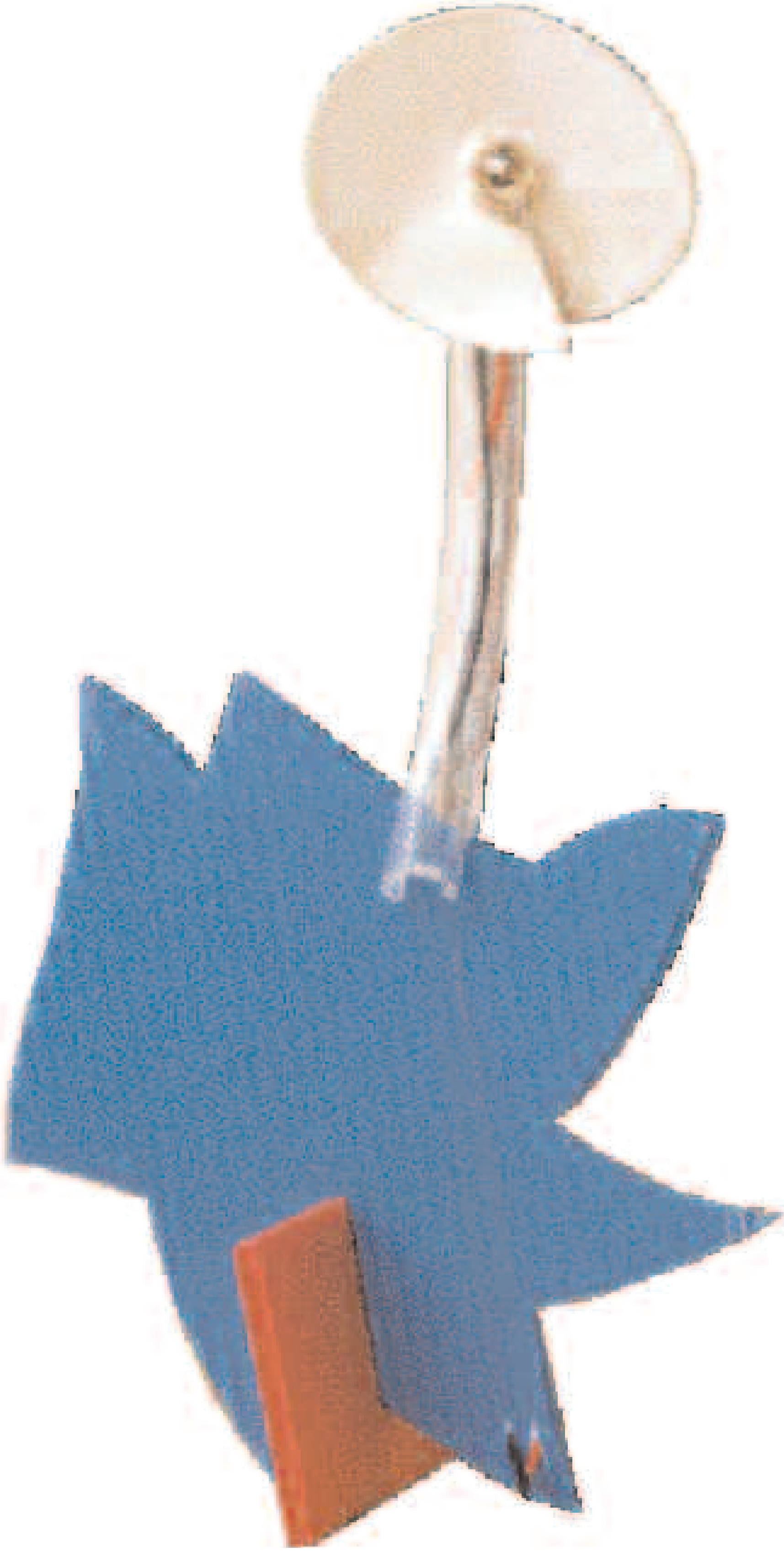


The effects of integrating the teaching of technology and science on elementary school students' performance

National Taitung Teachers College, Taitung 950, Taiwan, ROC
Rong-Jyue Fang – President. E-mail fang@cc.ntttc.edu.tw
Tung-Chung Tsai – Lecturer. E-mail tsaidj@cc.ntttc.edu.tw

Introduction

Technology education is basic education that equips elementary and middle school students with basic technology literacy for today's world.

The purpose of this study is to develop an instructional model for technology education and to understand the effects of integration teaching. This study aims to establish guidelines for related educational activities in the future. Related literatures will be analysed to develop a framework for the instructional model. Based on opinions gathered from interviews, and conferences with experts, we will further modify the model to enhance its adaptability.

The aims of this study are to:
1. *Analyse integration models for teaching technology and other subjects and to construct an adequate technology education teaching model and to develop experimental material for implementation;*
2. *Explore the developed teaching models and their effects on elementary natured science learning.*

Results of the study indicate the trend of integrating technology education with other subjects. The model consists of six teaching steps, which includes choosing topics, introduction, exploration, problem-solving, action, and evaluation. Experimental results indicate the active teaching characteristics, which can be used by teachers with flexibility. The instructional model will help promote the learning attitude and achievement of students towards technology and science.

Setting the context

The development of science and technology is a motivational force for national development, social progress and well-being of human civilisation and the good life. Therefore, the Taiwan government proposed four general aims for the development of science and technology:
1. To raise the level of science and technology
2. To promote economic development
3. To raise the quality of life of the people
4. To establish a self-sufficient national defence capability.

To enforce more science and technology in a school curriculum needs integration of whole courses. It makes learning more holistic, and reduces stress on individual subjects enabling more effective instructional activities (Zuga, 1988). Current subject integration emphasises the reconstruction of knowledge and experience. Basically, integration does not have boundaries. It considers the essential needs of the learner and makes topics, activities, and questions the core of better understanding It also encourages and enables students to be curious and creative and to develop their problem solving skills (Ortega, 1995).

Integration helps learners obtain more knowledge and skills. Our rapidly changing society strongly demands curriculum integration. Educators who are presently working on developing new and different types of integration models will have a positive and powerful effect on curriculum integration.

Traditional curricula are based on the understanding of independent technological systems. These systems include science, technology, and human systems. Students may learn these system through books and texts. However, traditional forms of learning lack empirical experience (Gilberti, 1992). Knowledge based education does not address the social context, and thus the value factor and student involvement is reduced.

The purpose of general education is to provide students with the ability to make critical decisions in the future and to share in the social welfare of the state and its duties and risks. It also aims at enabling students to be involved in social activities and become good citizens. Technology studies should also be part of the general education curriculum, because it provides the same sense of duty. Traditional instruction and its materials are simply not capable of providing these.

For these reasons, some science educators and technology educators have worked together to propose a Science, Technology and Society (STS) instructional concept. This concept focuses on students, how they learn basic science (technology) knowledge and skills, and come to understand the interaction of science, technology and society and how to implement such concerns to solve daily problems.

Educators know the importance of technology and its integration with other subjects. Most traditional courses are subject based. They are set up for the sake of convenience. Integration is applied only when complicated concepts are involved. (Wicklein and Schnell, 1990). Most educators stress independent thinking and problem solving (Baran & Sternberg, 1987, Nickson, 1988). It is easy to apply traditional instruction to achieve these purposes. Traditional instruction mainly addresses simple, easy, and low-level learning concepts (Saloman, 1988), and this over simplified kind of knowledge does not function well in the complicated circumstances of real life.

Purpose of the Study

This study investigates instructional models for technology education and its effects on actual teaching. The major purposes of the study listed as followed:

- To analyse integration models for teaching technology and other subjects and to construct adequate technology education teaching model and develop experimental material for implementation
- To explore the developed teaching models and its effects on elementary natural science learning.

Methodology

To construct technology and science instructional model, the study reviewed literature and proposed an ideal teaching model. Then, the investigator discussed with experts to identify a more practical model. To achieve a better teaching model, this study conducts a quasi-experiment. It applied "unequal controlled groups" for "pre and post-tests" and implemented an actual teaching experiment to obtain consequences with both theoretical and practical research results.

Findings

The research findings mainly obtained from six instructional stages are shown as follows:

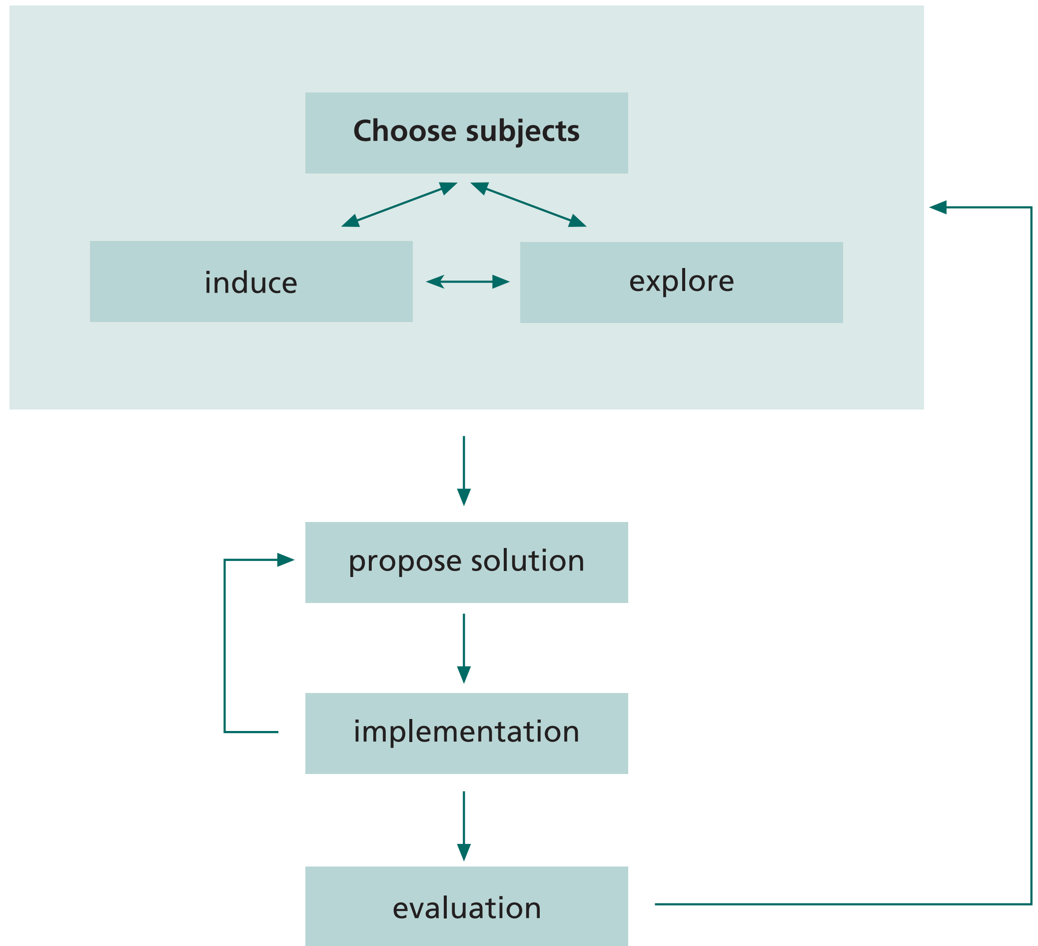
Technology Education Instruction and Creativity

The aim was to try to achieve better understanding as to whether technology education models are capable of promoting creative thinking. The investigator applied Williams Creative Test, which was modified in Lin and Wang's (1998) study as a tool to evaluate instructional effects. The findings indicate that students in Williams' Creative Test experimental group show not significantly differences in Fluency, Openness, and Title scores while compared with control group. In Versatile, Creative and Precision scores experimental group students showed significantly higher than those control group students.

Technology Education Instruction and Natural Science Learning

In order to find out whether the technology education instructional model really helped to promote elementary nature science learning, the researcher developed a natural science achievement test. The findings indicated that there were not significant differences between experimental group and control group students.

Figure 1 Instructional Model



Technology Education Instruction and Attitude Towards Science

The researcher focused on gaining a better understanding of elementary students' attitudes towards science whether the technology education instructional model provides support for students' attitude toward science? This research adopts Chen (1990) "science attitude test" as a tool to evaluate instructional effects. The findings indicate that the experimental group students showed significantly higher attitude scores than those of the control group students.

Conclusions

The conclusions were derived from the findings of the study. Four conclusions were drawn from the current analysis and will lead to the anticipated development of a model for technology education.

- Instructional integration includes six stages: choose subjects, induce, explore, propose solution, implementation, and evaluation. The instruction among first three stages reflects active characteristics of instruction. The teaching environment and study condition allow teachers more flexibility in choosing when and where to start among the first three stages
- Instructional model has significant effects on students creativity. But categories such as: Fluency, Openness, and Title did not show that significant differences might be caused by the limited training time while processing experiments
- Natural science learning achievement tests do not show a significant difference between the two groups. The possible reason might be caused by the limitation of teaching units while experimental instruction must go together with current teaching subjects. Also it contains too much cognitive learning, thus, it might not have direct effects on natural science learning achievement
- After experimental instruction, all of the attitude scales show that the experimental group students scored significantly higher than control group students. The possible explanation might be when the technology education instructional model is adopted; it makes learning more active with more interactions for the learner. This is especially true when contents expose more diverse samples of living technology as it activates students and makes them more willing to learn.

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Controlling Technology

The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK
Telephone +44 115 971 5574. E-mail j.m.flood@open.ac.uk
Jim Flood – Sub Dean of the Faculty of Technology

Introduction

This paper develops the argument that a great deal of the practical technology work in primary schools is not under the control of the teachers and pupils – and that this can reinforce negative typifications about technology and technologists in the minds of pupils. The paper provides examples of how teachers and pupils are being controlled by educational packages that place the pupil in the position of a simple functionary with little understanding of how things work – and with little opportunity to take control over the shape and form of the learning. The paper will point up the high incidence of failure to make things work satisfactorily, and how this can lead to negative self-esteem. The paper concludes by offering examples of appropriate technology that teachers and pupils can keep control of, is cheaper in real terms and provides a basis for success, understanding and learning.

Many of the broad aims of teaching technology focus on providing young people with competence and confidence in understanding and using technological systems. I do wish to endorse these aims but I seriously doubt if these are being achieved in many schools. The obvious reason for this is a lack of teachers with adequate training as well as lack of resources, however, I believe that this simply disguises a problem that centres on the interpretation of what technology is and what technologists actually do.

Most technologists spend their time working on the problem of making things work better. Better might mean making something go faster, use less energy, more user friendly, capable of being recycled or for a lower cost – this list is not exhaustive and you might like to brainstorm more factors with your pupils. However, better is a value judgement that is affected by trends, beliefs and knowledge – a point I will return to later. In brief, technologists tend to work on given problems and use their knowledge and imagination to improve existing systems and artefacts. An important aspect of the knowledge used by technologists is that of how things have been improved previously. One aspect of Henry Ford's success was due to the ruthless way in which he would take other cars to pieces to see what improvements he could adapt for his own use.

I want to contrast this model of how technologists behave with the thinking that appears to inform the teaching and learning of technology in schools. It would appear from my observations, conversations with teachers, the evidence in books and curriculum statements that pupils are expected to behave more as designers and inventors than technologists. Pupils are expected to take a problem, analyse it and to develop a solution. The emphasis of the process appears to be on the creative, qualitative and inventive rather that on the analytic and quantitative. Also pupils and teachers tend to spend so long making something that the important process of making it work better is rarely achieved. My conclusion is that things take so long to make and rarely work well enough (if at all) that any analysis with a view to making improvements is impossible. Two examples that come to mind are kites and rubber band or electrical powered buggies. Both of these examples involve a complex set of relationships that need to be carefully controlled if success is to be achieved. For example, in a kite, the angle of incidence (the angle of flight relative to the horizontal) needs to controlled by the bridle and the way in which the centre of pressure shifts as the kites distorts under the stress of air pressure. In the case of a rubber band or electrical powered buggy, the complexity lies in the way in which the energy is transmitted to the wheels through either a live axle or dead axle.

My analysis of the situation is that the complex relationships necessary to achieve success are not controlled by the teachers for a number of reasons:

- the complexity is not well enough understood by the teacher
- the ideological model of teaching and learning in this situation is not conducive to tight control
- control is abrogated to a kit or recipe.

Before examining these points further I want to reflect on the effect on the pupils of making things that do not work very well or at all. I have, over a number of years spent a lot of time talking to pupils of a wide age range about projects they have been involved in. The main reason given for things not working is that 'I'm not very good at this'. I relate this back to the broad aim of technology: how can we expect to build confidence and competence when the experiences we engage pupils in result in failure and negative self-typification? The pupils themselves do not feel in control and are more likely to feel alienated from the technological process than engaged by it. This, I believe, can have serious long-term consequences for how the future generation see themselves in relation to the technological infrastructure with which they live.

Returning to the reasons for teachers not being in control; the problem seems to me to be analogous to the attempts to introduce new and 'better' technologies to developing countries. Schumacher 1, writing in Small is Beautiful perhaps did more than any other writer to identify the alienating effect of an imposed technology which could not be controlled by the people who used it. A powerful tractor might well plough the land more effectively but the infrastructure to maintain it is not present, resulting in broken down technology and a reversion to traditional means of doing things. When an improved technology is introduced that uses local skills and local materials, so called appropriate technology, the indigenous people feel a sense of ownership and control of it; they learn to understand it by making and maintaining it. I do view many technology kits used in classrooms as the equivalent to a £50,000 tractor in Ethiopia – and I cite as evidence the number that have broken down and are gathering dust in a cupboard awaiting the appointment of an enthusiast, similar to the one who first used it. Like an indigenous population with a tractor, pupils have no sense of ownership over a kit.

I want to suggest and explore a number of guiding principles by which teachers and pupils might gain more control over the teaching and learning of technology:

- Begin with tools, materials, skills and knowledge that are familiar to a classroom situation
- Use some robust recipes to make things work (ie ones that you have tried and can make work yourself)
- Work on the basis that pupils have to experience success with making things work in order to develop positive attitudes and self-esteem
- Make things that can be made and re-made quickly in order to close the time loop that pupils experience between cause and effect …and the answers to What happens if… questions
- Work on the process skills of making the things work better
- Place the activity in a context that pupils can relate to
- Introduce new tools and materials only when the level of confidence is such that failure can be coped with.

An example for you to explore

Cut out a piece of paper to the shape above. Hold it vertically between thumb and forefinger at the point marked by the arrow. Before you release it, can you anticipate the path it will follow as it falls to the ground? Because it falls relatively slowly, could this be used as a technology to drop relief supplies from aircraft to people on the ground who are in need of food or clothing? How accurate was your prediction about how the piece of paper falls? By making changes to the shape, is it possible to control the direction and rate of fall? Is it possible to discern a pattern of how the paper falls so that you can predict where it will fall? Can you offer a possible explanation (hypothesis) for how the paper falls in the way that it does? And does this explanation help to predict where it will fall?

Within this activity there are rich possibilities for observing, guessing and testing, measuring, recording, fair testing (changing one variable at a time) and a discussion on how the model might scale up to a full-size version for dropping relief supplies from aircraft. It might also lead to a discussion on the means and ethics of supplying aid. Although using the simplest of tools and materials, this activity can presented in a way that will challenge pupils of all ages. In particular it provides for a very tight loop between making changes and observing the effect that such changes have.

Some other examples

Making a better:

- Wheel – use a lump of plasticene weighing, say, 100 grammes and shape it into different round shapes. Which will roll fastest down a slope? What can this tell you about the shape and size of car wheels, bicycle wheels and lorry wheels?
- Sycamore seed – use thin card and Plasticene to model a sycamore seed. Can you find out what makes the seed behave in the way that it does? What could a large version of the sycamore seed be used for?

There are examples of rubber band or electrical powered buggies that can be made from cotton reels, pencils and rulers – and kites made from one sheet of A4 paper – materials available in most classrooms (if you need details then do make contact with me). The key aspect of these examples is that they work first time and give pupils confidence that they can make things work – and they provide a basis for asking 'what happens if questions…' which can be answered very quickly. Most of these examples should be considered models of real things – and using models to explore ideas is a key technological activity to engage pupils in.

Summary

The history of technology is, in effect, the history of how, as a species, we have been able to continually improve the things we use for food production, shelter, transport and amusement (it is also the history of how we have improved weapons). Engaging pupils in the history and processes of technology is an important way in which we develop their technological literacy – the concept outlined by Raymond Williams 2 in 1961 to describe the language necessary for people to feel involvement in and ownership of technological developments.

Before teachers can take control of the technology they teach, they need to work within the skills, knowledge and materials that are familiar to them in classroom situations. They need to see the richness of the technology in the things around them, to learn from it and to pass this on to pupils through successful experiences in making things work – and making them work better.

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Designing and building: How children do this

IUFM – UNIMECA

Technopôle de Château Gombert, 60 rue Joliot Curie, 13453, Marseille Cedex 13, France

Telephone +33 4 91 11 38 21. Facsimile +33 4 91 11 38 38

Jacques Ginestié and Colette Andreucci

Introduction

This paper sets in context technology education in the primary school in France, and elaborates on how higher education could be involved to give it more meaning and status.

Research findings are given and analysed and suggestions made with regard to changing practice in teacher training

Setting the context

In France, technology education is not a specific subject for Primary schools. Gradually science and technology are differentiated from kindergarden (for five years olds pupils) and then run throughout the primary school (for pupils from six up to eleven years old). Two factors reduce drastically the significance of technology education in French primary schools.

Firstly, the teachers are non-specialist teachers. Their original fields of study are mainly literature (more than 50%), mathematics (approximately, 25%), human sciences (10%). A few are scientists and sometimes even fewer technologists. For the really large majority of teachers, there are no differences between science and technology. Technology, in the best case, is only a kind of applied science.

Secondly, there is not a specific place for technology education in the curriculum. The idea of strong links between science and technology is hardly encouraged. The new project for the development of science in primary school 'la main – la pate' (we could translate it by 'lend a helping hand') is particularly significant in relation to this particular idea. In the scientific part, the pupils have to observe scientific phenomenon and they have to do some experimentation to develop their understanding of basic scientific models. The technology education part is always heard as giving a shape to these rudiments of scientific models. The link is only a only way link; scientific models are put before technical artefacts, and there are not specific models in technology education but only applications or extensions of scientific models.

Training the teachers

The issue from these two points, is a debate about teacher training; how can we train teachers in technology education in primary school? in addition there is the debate about epistemology of technology in which knowledge plays a part. We take part in this debate by considering the perspectives of the didactics of technology education, specifically in terms of a study of transmission-acquisition of knowledge. The aim of this paper is to give you some ideas about the investigation we are undertaking and how we are proceeding.

Understanding the world of technical artefacts is one of the main goals of technology education in France. We have to see this question as the understanding of our connection with this world and how technology education could support this understanding. There is a need to demystify differing techniques and also support understanding of this connection. In this way, we speak about technical artefacts that are completely different from scientific artefacts. The way to observe something depends on the point of view a person chooses for the observation, and scientific and technological points of view are different. In other words, we could observe the same product from two different points but we do not observe the same aspects. In this respect, the distinction of the technical nature of artefacts is one of the most important ways of understanding it.

It is important that young children are helped to understand the technical aspects of artefacts. Piagets work about the genesis of world's representation tells us that children's ideas are based on the idea of artificiality before the notion of scientific casualty. From this concept of artificiality, a child thinks that all external phenomena are human work. A young child considers stars, rain, cloud, snow, and mountain as things built by man and created to address specific needs. This general tendency exists for seven to eight years old children and with a good degree of independence according to the place children live, for example in the city or country. All in nature seems artificial. We can observe a change in this concept and, for nine to ten year olds, this idea that nature is all made by man disappears. Does the construction of the natural aspect of things go with the construction of the technical aspect? To try to answer this question, we gave children of eleven years old a list of artefacts and we asked them to qualify their technical character. We could organise the children's answer into two categories: the good technical artefacts and the mediocre. We present you with some examples of each category.

Table 1	
Computer	94%
Pocket calculator	93%
Video game unit	
Electric deep fat fryers	
Electrix drill	
Sewing machine	92%
CD player	89%
Motorcycle	
Factory	87&
Compact-disk	86%
Telephone	
Tractor	
Movie's special effect	76%

Table 1 Good artefacts (the percentages indicate the number of children who think that this object is technical)

Table 2	
French bread stick	47%
Salad	12%
Bonsai	94%
Hamburger	59%
Jean	06%
Football ground	
Sugar	88%
Armchair	53%
Teddy bear	
Statue	
Igloo	
Soup bag	35%
Aspirin tablet	47%
Frozen food	
Game of monopoly	29%
Pick	

Table 2 Mediocre artefacts (the percentages indicate the number of children who think that this object is not a technical one)

These examples of what is a technical object or not for children of eleven years old show that it is not so obvious for them to determine one. We have to be precise in using the term technical object from an epistemological point of view. The technical aspect is characterised by the way in which it was created. In the first instance, we could consider that an object is a technical one when it results from the intentional action of humans. From this point, it is clear that this concept is not one which is considered by young French children. The second approach takes account of the rationality of this process: technical artefacts which are the result of an organisation of clearly identified techniques. We could identify practice, knowledge, know-how and context by which, and in which this particular artefact exists. Children cannot use these concepts to discriminate technical artefacts. The causes of this misunderstanding certainly take place in children's development but, maybe also, as a result of the deficiency of technology education.

Technology education could define technological knowledge which would support pupils' activities in significant tasks. One aspect is the meaningfulness of this construction; another aspect is respectful of the children's development and their abilities. We speak about the lower place given to technology education in French schools that is largely confused with handiwork practices. One of the problems to solve is how to extend these practices and give them a technological meaning. We could consider the three parts of our purpose: knowledge, task and activity.

Knowledge

Which are the main concepts of technology education and how can we make this knowledge clear for schools? We speak about the distinction of a technical artefact as the result of a human organised and rational process. We could view it from two points:

- A technical object integrates the relationship between functioning, functions, structures and form. An artefact exists to answer a specific use but also to give some symbolic signification to its owner. This double purpose defines the value we give to artefacts through two different kinds of functions: using function and signing function. The form of the artefact depends on the structural transformation of these functions. From this point, the final solution is a compromise in which material, assemblies and components are only one answer among many to this problem. There are not necessarily bad or good solutions, only one solution integrating all the constraints of the problem; a global integration in a particular form composed by an assembly of structures in which functions allow functioning to satisfy previous use and user needs
- An organised and rational process by which an artefact exists, integrating two important aspects. On the one hand, all that is make, is planned in advance. The demand for this planning is not a need for rationality's sake, but an adapting answer to the distinction between the planner and the underling, an explicit reference to the social division of labour. Through this, we could find the description of different professional activities, the social organisation of labour, the process by which new artefacts appear, the necessities of formal language facilitating the communication between the different groups and the interrelations between design-manufacturing-distributing.

Tasks

These points open perspectives for the tasks proposed to pupils. We could see the influence of the task on the pupils' performances. To illustrate this, I take one example we studied about the elaboration of an automated system with LEGO. We have two groups of pupils (around eleven years old) and two tasks, worded differently. The problem to solve is to sort translucent bricks out among opaque ones.

The first wording is a classical wording in France; pupils have to follow a guideline step by step to the expected solution. This approach develops with strong guidance of action, and pupils' interest is centred upon the structure organisation of the LEGO bricks. The second wording is drastically different and poses an open problem without any indication of a possible solution. The analysis of the results shows some interesting points.

In both cases, the pupils arrived at a functional solution. They built a system which sorted the bricks. The first group arrived at an expected solution. The system is a conveyor belt with a photocell and a mechanical arm. The second group proposed a trolley system. The selection of the bricks is made by a displacement method on the trolley. Linked to the unloading of the bricks in two different places and is made by fixed arms above the trolley. The first solution is based on a technical known solution whereas the second is an original pupils' solution.

The task analysis allows us to compare the purposed solution to some technological possibilities. We could value each element of this solution in terms of pertinence with technological aspects. From this point, the solution of the first group is more relevant than the solution of the second one. That does not mean that pupils of the first group have a best conception of the system or they have a good problem solving process. For the illumination of these points, we have to analyse the activity of the pupils.

Activity

Analysing activity, as we do it, relies on two schemes, customary scheme and instrumental acts' scheme, and a material device. The customary scheme focuses on procedures, instrumental acts' scheme focuses on functions. The first group of pupils developed a procedural strategy whilst the second tried to build instruments in a functions' articulation strategy.

For the first group, we could note activities' development without any kind of interrogation about the functioning of the system. All the exchanges between the members of the group are centred on the structure arrangement. For example, they do not understand the role of photocell and light:

- Pupil A: 'what is it?' He shows the photocell brick.
- Pupil B: 'I do not know. It is a special brick'
- Pupil A: 'Look at, this one is a light.' He shows the LED and the wires
- Pupil B: 'Right on, this one also is a light but an invisible light'
- Pupil A: 'Well, there is this light,' he takes the light brick in his hand, 'for lighting the transparent brick and the invisible light for lighting the opaque brick'
- Pupil B: 'What we have to do?' They took notice. 'Well, this yellow one,' it is the photocell brick, 'go here and the blue one,' it is the light cell go here, 'go there.' He puts the bricks as the notice indicates.

This dialogue is significant as an exchange on structure. The guidance device is strong enough to mask the functions they can't solve and a minimal explanation is largely sufficient to progress. We could see that they take in game only operational schemes. The strategy they adopt is composed by a succession of affirmations. They reject if they are in front of an element they can't solve quickly and easily. This rejection is largely linked with the structural aspects.

The second group works at functions' level. About the same question of discrimination of opaque or transparent bricks, we find this kind of dialogue:

- Pupil C: 'There is a problem, how could say to the trolley this is an opaque or a transparent brick.' He turns the trolley in his hand.
- Pupil D: 'You know, it is easy, there is a transparent brick after one opaque, we just have to count the brick and then if it is an odd number, that means the brick is opaque and if it is an even number that means the brick is transparent.' He shows the place where the bricks arrive and he simulates the bricks arrival, one opaque, one transparent
- Pupil C: He plays with the bricks and marks a long hesitation's time: 'but if there are two opaque bricks following?'
- Pupil D: He seems indifferent at the comment of his friend and does not bring attention to his comment: 'Well, how could we count the bricks?' He searches in the LEGO box for something for counting but without any conviction; he seems absorbed by his thinking
- Pupil C: 'No, it is not possible, we could not count it, you are wrong, it is not the good way because we don't know if a transparent arrives after an opaque.'
- Pupil D: He seems totally out of the situation, he looks out the windows, chews his pencil and without conviction says: 'Sure, we have to count the bricks, one opaque, one transparent and so on'
- Pupil C: 'No, it must see if the brick is transparent or not.'
- Pupil D: 'Yes, transparent? But how could it know if it is transparent?'
- Pupil C&D: they try to find out from the description of the different bricks. They appear in a non-issue strategy, they exchange bricks without speaking for a long time. They try to find a solution in the different bricks
- Pupil D: 'You know, in my car park, there is something which opens the door when the car arrives, you know?'
- Pupil C: 'You mean when you cross the light, the door opens!'
- Pupil D: 'Exactly, we have to do that, a light barrier for the opaque… The opaque cannot cross the barrier… but the transparent yes.'

The way to a functional solution is a long way off. The children have to solve a lot of problems but, finally, they arrive at producing a good functioning solution. In this case, the exchanges are founded on this schematic strategy: which is the function, how could describe this function, which structure is able to answer to this specific function. Every time they try to solve a function's problem by a structure solution, this choice becomes an impasse for them. But they progress by hypothesis on the functionality of the system and by carrying out functions they do. Without any doubts, we could think that this manner to solve the task is more efficient for the learning process. The pupils act with instrumental acts' scheme. From the teacher trainers' point of view, we have to purpose some situations in which pupils have to think by themselves. The non-guidance activities are not a usual way of teaching, but we have to contribute to change it.

A Conceptual Framework of 'Clay' on Fine Arts and Technology Education Programs at Taiwan Primary Schools

Department of Fine Arts and Technology Education, National Taichung Teachers College in Taiwan
Telephone / Facsimile +886-4-2234749. E-mail hcs@mail.ntctc.edu.tw
Chia-sen Jimmy Huang PhD – Associate Professor and Director of Media Center

Introduction

In Taiwan, technology education is called 'fine arts and crafts' at primary school level. At this primary school level, craft is similar to industrial arts, which before 1975 had an emphasis on work education.

The purpose of this study is to introduce a conceptual framework using 'clay' linked to the background and current implementation on fine arts and technology education in Taiwan primary schools. The concept and teaching project was directed by Professor Lin, who worked at Taiwan National Taipei Teachers' College. The teaching project was also implemented at Pie-Shing primary school in Taipei county in Taiwan from 1992 to 1998.

The current status of technology education in Taiwan primary schools

The goals of technology education in the 1996 New Curriculum are to provide an understanding in the areas of presentation, appreciation, and practical application of the arts. The New Curriculum also provides an appreciation of the technology designed to upgrade the quality of life. The contents of the New Curriculum are based on the fixed objective for each year and are divided into three areas: presentation; appreciation of the arts and practical application.

Practical application covers the knowledge and skills of technology education and tries to relate it to the students' own lives. The course of technology education is two teaching hours per week for 1st and 2nd grades, and 3 teaching hours per week for 3rd-6th grades. The instructional methods of the New Curriculum are principally through hands on experience, audio visual materials, and field trips. The aim of instructional strategies on the New Curriculum is to provide a comprehensive and systematic program of activities ranging from basic introductions to in-depth analysis. The program of the New Curriculum should enable students to acquire a clear understanding of the entire technical and making process, from the planning stage through to the finished product. The evaluation of the New Curriculum is on process, result and teamwork. Moreover, teachers should also take into account the students' attitude and performance.

The characteristics of New Curriculum on Taiwan primary technology education

The new 1996 curriculum for primary technology education in Taiwan has the following characteristics:

- Humanistic – emphasising teaching and the students' psychological development
- Applicable – suggesting students' work to be applied to their daily life
- Prospective – corresponding to the current technology education of the world
- Flexible – being reflective for the arrangement of teaching hours, textbook selection, and teaching content
- Interesting – offering diversified teaching materials and strategies to students
- Individualised – emphasizing students' learning diversity
- Artistic – students' work is requested to correspond to the artistic principles
- Integrated – the curriculum structure is designed in accordance with Tyler's three elements:
  1) continuity
  2) sequence, and
  3) integration.

The rationale of the teaching project

- Tyler (1949) indicated the effective curriculum consists of three criteria: 1) continuity, 2) sequence, and 3) integration
- Oliver (1977) offered three characteristics of curriculum organization: 1) articulation, 2) balance, and 3) continuity
- Taba (1962) indicated that the curricular arrangement needs to consider: 1) teaching content. 2) teaching process, and 3) students' psychological development.

Continuity means that the curriculum needs to overlap teaching content during the different learning stages. The main purposes of continuity are to repeat the classes to avoid forgetting. The sequence (articulation) means that the curriculum can offer the classes from basic to complex. The integration (balance) means the relationship between students' learning situation and their ability of application.

The teaching project was designed using the environment. The environment can be divided into four areas: 1) human being, 2) nature, 3) society, and 4) image. Each area can offer several conceptual frameworks for teachers from which to design their teaching activities including presentation, appreciation, and practical application. The conceptual framework of clay is an element in this project. The element of clay is always considered by three variables: 1) children's ability, 2) social culture, and 3) biological factor. The structure of 'clay' in this teaching project includes five topics as follows: 1) nature of clay, 2) function of clay, 3) culture of clay, 4) history of clay, and 5) the life of clay.

Teachers are requested to effectively direct students to utilize the diversified materials and related skills in this teaching project.

The contents of the teaching project

The conceptual framework of clay in the teaching project contains eighteen lesson units for students to learn step by step from Year 1 to Year 6. The content focus of the teaching project contains the following aspects:

- Games and psychomotor activity
- Discovery of clay
- Manipulating clay
- Decorating clay
- Producing clay products of daily life
- Presenting the image with clay
- Understanding the process of glazing and firing
- Appreciating art works made from clay
- Discussing clay from Taiwan's history and culture
- Expressing the concept of clay by painting.

The structural analysis of the teaching project also includes the following keypoints:

- Learning by sense of touching, feeling and discovering
- Learning by doing
- Direct instinct thinking
- Discovering the image of clay through application, models and structure of clay
- Symbol and icon learning
- Painting history and life of Taiwan's land.

The detailed lesson unit, content focus, and structure analysis are listed in Table 1.

Table 1 The conceptual framework of clay

Grade	Lesson Unit	Content Focus	Structural Analysis	
1	•Treasure of clay •Mud playing •Clay playing	•Games & psychomotor activity •Discovery of clay •Clay elasticity •Learner's interest •Tactile & sense activity of clay •Manipulating clay	•Psychmotor activity •Arising learning awareness •Breaking preconception of clay •Introducing nature of clay	•Learning by sense of touching, feeling, & discovering
2	•Mother & me •Slab drawing •Who can pile higher?	•Expressing relationship between mother & me with clay •Sculpturing on clay •Clay modelling & space combination	•Manipulating skills •Format of clay as a medium of art creativity •Divergent thinking skills •Creativity & imaginary	•Learning by doing •Direct instinct thinking •Functioning of clay
3	•Ceramics bell	•Clay functioning •Shaping methods	•Knowing functioning of clay •Basic skills of manipulating clay	•Discovering the image of clay through application, models & structure of clay
4	•Pen container •Savings box	•Producing clay products of daily life	•Discussion of clay from the perspectives of life, history, culture, & relationship between clay & human beings •Advanced skills of presenting the image of clay •Transmission of culture heritage •Arising attention & concerns of Taiwan's local history •Advanced manipulating skills and practising of clay products •Divergent awareness of clay as medium of art creativity •Life functioning of clay •Creativity of modelling clay	•Symbol & icon learning, analysis, deductive thinking •History & life of Taiwan's land
5	•Movie of 'root' •Strong human being •Visiting snake kiln •Hole firing •Firing & glazing •Appreciating unique art works of clay	•Thinking of relationship between human being & the land •Presenting the image of 'being strong' with clay •Understanding 'snake kiln' on its historical role in Taiwan's early life •Understanding the structure & operation of firing •Experiencing the process of glazing & firing •Expanding the freedom of creating module of clay	•Nature view of clay from perspectives of science, sense & generalization •Cultural & historical perspectives of clay •Essence of clay •Experience of Taiwan's land	
6	•Discussion of clay •Taiwan's land •Drawing Taiwan's land	•Understanding initiation, appearance & characteristics of clay •Discussing land from the perspectives of Taiwan's history, culture, & daily life •Thinking the relationship between land & the human being •Expressing the concepts of Taiwan's land by painting		

Linking science with design and technology in the primary classroom

Institute of Education, Warwick University, Coventry, England, CV4 7AL, UK

Telephone +44 1203 524376. E-mail r.johnsey@warwick.ac.uk

Rob Johnsey – Lecturer in Primary science and design and technology

Introduction

Design and technology has the potential to provide meaningful contexts for learning in the primary school. The case has often been made for using the subject as a vehicle for learning (The Design and Technology Association (DATA), 1996 p. 1.3) by exploring suitable cross-curricular links. The problem is that most models for a cross-curricular approach in the primary school do not exploit fully the potential that this unique subject has.

This paper describes one mechanism by which true integration between design and technology and other subjects might be achieved. It will go on to illustrate this approach by outlining a curriculum development project in which science was taught through design and technology in the primary classroom. The curriculum materials are based on topics from the English National Exemplar Schemes for both science and design and technology (The Qualifications and Curriculum Authority (QCA), 1998a and 1998b).

Benefits of linking science with design and technology

Linking subjects within the primary curriculum requires careful thought and planning and has not been made easy by the way in which the National Curriculum and the subsequent exemplar schemes of work have been developed along subject lines. It is worth, therefore, considering the distinct advantages that exist for linking subjects such as science with design and technology in the primary school.

One of the benefits of integrating subjects is that it enables children to study the same concept or skill from differing viewpoints and subject disciplines and thereby reinforces understanding. Children do not perceive the world in terms of subject compartments as much as teachers do and so it seems more natural for them to study skills and concepts rather than curriculum subjects. Many of these skills and concepts lie on the intersection of a number of subjects. DATA provides an analysis of the overlaps with design and technology and other curriculum areas (DATA, 1999 p. 10). For example, in both science and design and technology children will learn skills such as 'using both first hand experience and secondary sources to obtain information', 'planning ahead' and 'using results to draw conclusions'. The two subjects share knowledge and understanding such as 'the uses of common materials are related to their properties' and 'controlling electrical circuits'.

Just as important, and possibly an even stronger justification for linking subject in schools, is the fact that skills and concepts can be reinforced if they are put to use in different contexts. Design and technology is a subject which is well suited to exploit this particular advantage.

'One of the strengths of design and technology in the primary curriculum is that it offers practical opportunities to draw upon and develop skills and knowledge from a variety of subject areas' (DATA, 1996, p.3.2.3).

Children carrying out design and make tasks will need to draw upon ideas not only from the knowledge and understanding section of the design and technology curriculum but also from science, maths, art and so on. In the Crafts Council enquiry into the value of making within the school curriculum (Crafts Council, 1998) the point is frequently made that pupils in secondary and especially primary schools learn very effectively through making things in a variety of ways. The authors might easily have added the word designing since it is well understood that often children are involved in designing at the same time that they are making something (Johnsey, 1995).

Some members of the science community have expressed strong opinions about the need to re-establish links between science and technology. The authors of Beyond 2000 – Science Education for the Future suggest that '…young people's natural curiosity about technology is a hook on which we can build an understanding of science…' (Millar and Osbourne, 1998, p. 19) They tend to view technology only as a means by which to illuminate key scientific ideas. This paints only a part of the picture and unfortunately ignores the fact that scientific ideas more often service the needs of the technologist. The authors further reveal their particular view of design and technology by referring to the need, in science education, to '…go beyond the limitations of the D&T workshop…' to explore the more sophisticated technologies such as the construction of contemporary buildings, as though this would not be within the remit of design and technology.

Within primary education, then, most teachers would be happy with the notion that subjects such as science and design and technology can be mutually advantageous, but would need to consider how best to achieve this. This paper sets out to describe and illustrate one way in which these advantages might be exploited. It describes a mode of curriculum delivery which is unusual in primary schools where a design and technology topic acts as the central theme and provides the purpose for learning scientific ideas.

Description of general mode of curriculum delivery

The particular mode of curriculum delivery used in this project depends on an understanding of the concept of design-related research which has been developed in a number of publications (DATA, 1996, Johnsey, 1998). If design-related research involves children finding out information which might support their designing and making then this could clearly take a variety of forms. Within design and technology children carry out focused practical tasks (FPTs) and investigative and evaluative activities

(IDEAs) as part of their research. Equally however, they might carry out a related maths, science or art activity. If the teacher is able to plan a design and make assignment which requires the understanding of scientific ideas for its successful completion, then a firm link will have been made in which one subject truly enhances another.

The curriculum development project described here involved trials in four primary schools over a 10 week period in the spring term 1999. In each case the same pattern of delivery was used but with different topics and age groups. The basic pattern was as follows.

- Introduction to the 5 week project in which the design and make task was set
- Children record the information they think they need in order to complete the task
- A series of teacher-led science activities are experienced by the children as part of their design-related research
- The children record the specifications they required for the product they are to make
- They model their ideas and communicate these in a variety of ways
- The children make their products
- The products are evaluated by referring to the specifications made earlier.

At the end of each project a sample of children were interviewed about their product and the science ideas which had been used in its development.

Description of 4 case studies

The trials in the four schools took part in two 5 week phases and involved the following projects which were taken from the exemplar schemes of work for science and design and technology (QCA, 1998a and 1998b).

	Trial year group
Phase 1	
Pushes and pulls with Moving pictures	Year 1
Changing Sounds with Musical instruments	Year 5
Phase 2	
Circuits and Conductors with Torches and Lamps	Year 3
Friction with Moving toys	Year 5

Case study 1 – Pushes and Pulls with Moving Pictures: The Owl and the Pussy Cat

In this project the children were given the task of illustrating the story The Owl and the Pussy Cat by Edward Lear by making simple puppets. Despite the fact that they had limited experience in making products they were able to define a number of things which they would need to find out including which materials would they be able to use and how to make a fluffy body for the owl.

The children spent some time thinking about the kinds of movement that the characters might make and extended this to the movement of other things. The link was then made between movement and the pushes and pulls that produce the movement. The children considered their own movements and the muscles need to achieve these. In a focused practical task the children made simple sliding mechanisms and lever mechanisms and thought about how pushes and pulls were needed on these.

As a class, the children agreed on some specifications for their puppets. They were to have a supporting stick which was easy to hold and to have one moving part and the puppets had to look fantastic! The children went on to model their ideas for the puppet by cutting or tearing pieces of paper to represent the animal. These pieces were laid out on the desk and rearranged until they looked right. This modelling procedure enabled the children to make mistakes and change their minds about parts of their model.

The final puppets were made with plenty of adult help. Each had a supportive handle and a control rod to make a hinged limb or head move. Some of the children were able to recite the poem by heart as members of their group performed with the puppets. Finally the children completed a simple evaluation sheet in which they referred to the specifications set out earlier. Some children were able to add to the class list of specifications with ideas they had thought of as they proceeded. They included statements such as The puppet should "be colourful", "not be too small" and "be seen from far away".

Case Study 2 – Changing Sounds with Musical instruments

This project was introduced with a mystery sound quiz in order to establish a working vocabulary for describing sounds. The children were introduced to their design and make task – Work in small groups to make a set of musical instruments to accompany a television commercial or a science fiction film. The instrument should make more than one kind of sound.

The children were able to record the kind of information they needed to find out in order to complete the task. Many of their ideas anticipated the science activities which had been planned for them. Suggestions included, 'How to make different sounds from one string' and 'Do hollow things make better noises than instruments which are not hollow?'

A series of science activities followed in which the children explored making vibrations and making different pitch notes using a variety of simple classroom objects such as elastic bands and polythene stretched over thick tubes. One activity involved a science investigation in which the amplifying properties of hollow boxes were explored.

The children went on to make specifications for their instruments, examine a range of construction materials and communicate their ideas through drawings. Each group of about 6 children planned to make a range of instruments, which included beaters, twangers, scrapers and shakers, in order to compose a short musical piece on the theme of their choice. A class evaluation was made after each group had played their piece and this was followed by individual written evaluations.

The teacher reported an increased motivation in the pupils because they were looking forward to putting their science ideas into practice in constructing the instrument.

Case study 3 – Circuits and Conductors with Torches and Lamps

This integrated project involving science and design and technology has been well documented by others in the past. There were some features in this trial, however, which were incorporated as a result of the trials described in the first two Case Studies. A conscious attempt was made to adapt the science activities to make these more relevant to the design task.

The children, who had no previous experience with electricity in a formal school lesson, began by considering the use made of electricity in the world around them. They went on to make a bulb light up with a battery and length of wire and quickly learnt how to use crocodile connectors, bulb holders and more than one battery.

The children made a press switch, turn switch and a sliding switch from aluminium foil, plastic and card which could be adapted for use in the torch the children would eventually produce. In this way the science activity could be more closely associated with and therefore adapted to the design and make task.

The children went on to design their torches or lamps by considering the particular needs of the person form whom the torch would be made. Specifications were drawn up and drawings were made which showed the path of the wiring in red felt pen over the shape of the torch.

Case Study 4 – Friction with Moving toys

In this project the children were asked to design and make a toy in which something bobbed up and down (worked by a cam) and something else turned around (worked by a vertical wheel rubbing on a horizontal one). Such a toy enables friction to be both useful and something to be overcome.

The science activities carried out by the children were not the conventional ones in which a block is pulled over a surface in order to measure the friction involved. A different activity was devised which achieved the same science objectives but bore a greater resemblance to the product which was to be made.

In the first activity pairs of children used a card box 'rig' in which a turning wheel was set up on a wooden axle (Figure 1). A rod resting on the wheel provided a friction force which was measured by turning the wheel with masses suspended from the axle. The friction was varied by adding different materials to the underside of the rod and reduced by applying a lubricant such as cooking oil to some of the surfaces.

A second activity used a similar card box 'rig' to investigate how a vertically turning wheel could turn a horizontal wheel and how increased friction would help the process (Figure 2).

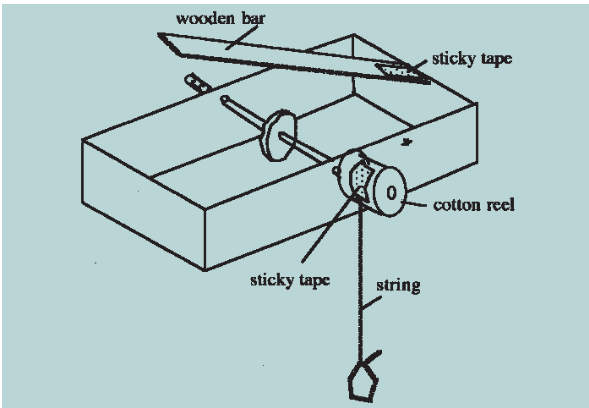

Figure 1 Rig used to investigate how to reduce friction

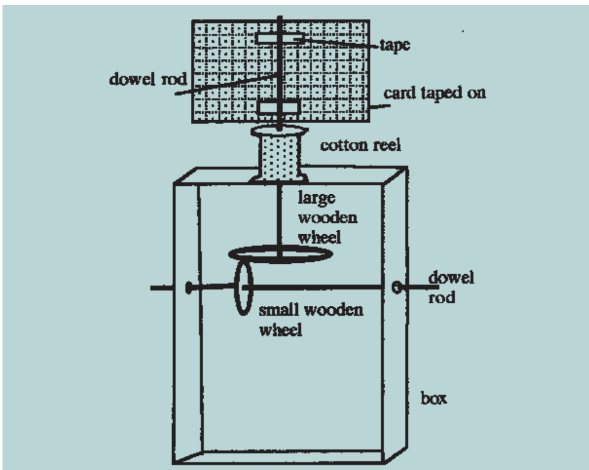

Figure 2 Rig used to investigate how to increase friction between wheels

The children went on to make a wood strip frame for their toy and incorporate their mechanism within this. Much time was spent in construction and in overcoming technical problems in making the mechanism work. In discussion with a small number of children after the project was complete it was possible to make an effective assessment regarding the degree to which ideas about friction had been learnt.

Lessons learnt

Teachers in the trial schools thought there were advantages to teaching some scientific ideas with design and technology in, what appears to the children to be, a seamless project. They felt giving the design task to the children early in the project had a beneficial effect. It provided additional motivation to learn the science and had a unifying effect on the whole project. Much science was learnt, not only in the science investigations, but later when the children were designing and constructing their products. Furthermore the process of designing and making and evaluating what had been achieved proved a valuable insight into just what science had been learnt.

The idea that children easily transfer skills and knowledge learnt in one situation to another is temptingly simple but fraught with problems, some of which were encountered during this project. McCormick (1999) identifies the 'device knowledge' required when children design and make and argues that this is often in a different form to that taught in a science lesson. Millar and Osbourne (1998, p.19) also, acknowledge 'that there is work to do to explore the implications of teaching part of the science curriculum with the aim of "technical know-how" rather than abstract formal knowledge…'. Some thought, therefore, needs to be given to the form in which science knowledge is presented to children if they are to be expected to apply this in new contexts.

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The fruits of Technological Literacy: Wild varieties or crops of mass production?

School of Education, Underdale, University of South Australia

E-mail Steve.Keirl@unisa.edu.au

Steve Keirl – Coordinator of Technology Education

Introduction

This paper explores the concept of Technological Literacy and critiques its applicability to primary design and technology education

The paper:

- *reviews the literature on this topic;*
- *outlines the ways in which the concepts of technology and literacy have common bases, notably in their shared socio-cultural constructions;*
- *outlines the politics of Technological Literacy and the claims and influences of competing interests on the primary curriculum;*
- *draws on the work of Lankshear (1998) and his three-dimensional/four constructions view of literacy per se to develop a view of Technological Literacy which is not narrow and instrumental but, rather, is rich and critical-emancipatory in nature.*

The author argues that, if the concept of Technological Literacy is to enhance primary curriculum and democracy alike, then we must concern ourselves less with the mass production of crops of students and more with the growth of wild varieties whose blooms will serve to enrich society.

Setting the context

Technological Literacy is a term that has enjoyed varying degrees of usage over at least the last two decades and the latter years have witnessed a surge in its profile (see, e.g. Dyrenfurth 1987, 1992; Beynon & Mackay, 1992; Lewis & Gagel, 1992; Custer et al, 1993; UNESCO, 1993; Waetjen, 1993; Wright, 1993; Layton, 1993,1994; Liao, 1994; Raizen et al, 1995). The literature ranges from the naive to the enlightened.

A couple of these authors rightly question whether the term isn't anything more than 'a catchy name' (Dyrenfurth, 1992:397) or a fashionable hit. It has certainly become a convenient sound-bite for politicians who voice the need for a 'technologically literate society'. Many educators would share this view but we soon find that just what constitutes Technological Literacy depends very much on the user's perspective, values, interests and politics.

It must be a matter of concern to educators, when faced with yet another slogan in the already crowded curriculum, that there is little agreement as to ways forward. This paper cannot provide Primary School Educators with a set answer to the question of just what is Technological Literacy. Whatever it is, I would argue that it needs to be an unstable and contested term and that clarifications of the definition type are of little use. What I hope to provide is some sorting of the issues and an argument in support of holistic and critical-emancipatory interpretation of what Technological Literacy can be for our students and future citizens.

Political currency and technology

I should also state from the outset that Technological Literacy, however constructed, must relate to social organisation and issues of empowerment. A key example comes from a dominant technology of today – I(C)T. The fact that information technology is high on political and industry agendas is well addressed by Mackay, (1992); Luke (1992a,b), Apple, (1992); and Roszak, (1996).

For now, let's compare these quotations:

Today, technological literacy – computer skills and the ability to use computers and other technology to improve learning, productivity and performance – is a new basic that our students must master. Preparing our children for a lifetime of computer use is now just as essential as teaching them to read and write and do maths. Every major U.S. industry has begun to rely heavily on computers and telecommunications to do its work. (Bill Clinton, 1998)

The invisible pedagogy of the computerised curriculum is systems oriented and like the hidden curriculum of Computer Literacy its concealment is essential to its primary function of socialisation. (Broughton cited in Beynon, 1992:23)

Women, ethnic minorities, the urban poor, indigenous peoples – the historic outsiders of technologies of power – are forming up the ranks of new regional global underclasses of the information and technology 'poor'. (Luke, 1992b:viii)

That these groups have been the 'technology poor' and that education has served to socialise students to industrial wants are hardly new phenomena – regardless of the predominant technology – but the quotations remind us that political agendas and trends are not insignificant. What then of technology proper?

The Nature of Technology and Technology Education

As Young (1991) put it:

Technology has no unambiguous meaning except with reference to specific technologies, though it has powerful rhetorical and ideological connotations. It subsumes and is often equated with a whole range of notions such as being modern, progressive, practical, politically neutral, economically relevant, productive, efficient, quick, reliable, accurate. (Young 1991:235)

(Although I might prefer the analogy drawn by Green (1995:xxxix) that 'framing technology is like trying to nail jelly'.)

I believe all such views are valid. Not only is this an emergent field of education with sparse research underpinning it, but also, it is dynamic and necessarily prone to change, critique and contestation. Furthermore, I suggest (Keirl, 1999) that the field is subject to a range of orthodoxies from which it is often critiqued. Thus Technology Education is defined by default, that is by making comparison with something else, or it is defined by stereotype. Indeed, these are orthodoxies of ignorance which must be addressed. Briefly, they are the orthodoxies of:

- Technology as new
- We being toolmakers and users for two and a half million years or so
- Technology as things
- There are problems with the objectification of technology without acknowledging that these objects are interacted with by people
- Technology as neutral
- This orthodoxy is a co-habitant with technology as things when attempts are made to apportion worth or otherwise to the technology itself rather than to the human behaviours and relationships which accompany it
- Technology as 'hi-tech/l-tech'
- Technology is not just computers or Information Technology. The latter is merely a sub-set of the former. It may be dominant, pervasive and current but that is all it is
- Technology as 'applied science'
- Similarly, it is time to disengage from the now tired notion that technology is applied science. This stereotype has now run its course
- Technology as inevitable
- There exists the extremely powerful orthodoxy of technological determinism which is given currency by those who maintain that the flow of new technologies and their accompanying change are all inevitable and that we have little or no choice over the technologies we use or create
- Technology as incomprehensible
- Finally, I would suggest that there is an orthodoxy which engenders complacency towards the seemingly incomprehensible nature of technology and its consequences. The feeling of being 'overwhelmed by it all' can lead to the very complacency and passivity which weaken democratic society.

That Technology Education has substantial breadth, as well as huge potential in schools, is attested by recent international studies (Layton, 1994; Black & Atkin, 1996). Layton provides key evidence of the contestation of Technology Education by identifying 'six principal actors in this curriculum drama', namely: economic instrumentalists; professional technologists; sustainable developers; girls and women; defenders of participatory democracy; and, liberal educators. There other groups too, and within each group there is extensive debate about what Technology Education should be.

Add to the orthodoxies and the stakeholders agendas the unresolved question of whether there exists a body of knowledge for Technology Education and the arguments to support an ethical dimension to Technology Education (Keirl, 1998) and it is hardly surprising that Layton says:

…the politics of technological literacy – who creates and controls the meanings of the phrase, how the imposition of meaning is attempted – is a central concern of technology education today. (Layton, 1994:13)

How has Technological Literacy been constructed?

Custer et al. (1993) offer five possible interpretations and, clearly, these are reflected in Layton's findings:

1. Democratic – to have a literate society is to have a critical citizenry and, therefore, a fully functional democracy
2. Economic – the economy will be healthy if the workforce is technologically literate
3. Employability – technological literacy is measured the extent of skilling/multiskilling held by a worker
4. Discriminatory Consumer – technological helps us make useful judgements about the products we use and buy.
5. Liberal Education – for students and citizens to reflect on, and critique, both technology and technology education. (Custer et al, 1993)

Waetjen (1993) and Dyrenfurth (1987, 1992) both critique understandings of Technological Literacy which remain in the conceptual rather than the practical domain. For them, doing must be a key to being technologically literate. This practical – conceptual debate arises in discussions of technological knowledge too and the positivists, mostly male, reinforce their case with particular assessment strategies of the instrumental and reductionist type. These approaches often reflect industrial and professional interests. Dyrenfurth links 'workforce competencies' with the purposes of Technology Education and comes to the conclusion that ' …there is a remarkable convergence between what the private sector calls for and what the core of the technology education profession seeks to deliver' (Dyrenfurth, 1992:399). Surely Technology Education is about rather more than matching what industry 'calls for'. Thus, if one's perception of Technological Literacy is instrumental then the associated assessment practices will be articulated through reductionism, 'standards' and 'competencies' – all of which are becoming increasingly common.

The desire to have instrumental interests inhabiting Primary Design and Technology curriculum have been starkly exemplified in Australia. A recent report argues that 'science and technology' (sic) should be delivered in primary schools in their role '…by which future generations of scientists, technologists and engineers are trained' (ASTEC, 1997:4).

Moving on from the instrumental…

A much richer discussion of Technological Literacy is possible when the broad aims of education, and its place within democratic society, are addressed. (Similarly, when Technological Literacy is considered as a cross-curricular and learning theory integrator (MacGregor, at this conference). For example, the New York State Education Department (1986) saw technology as ' …an integrating discipline designed to develop technological literacy as part of all students' fundamental education…' (Conroy & Hedley, 1990:231). There are two dimensions involved here. First, the concept of technological literacy is identified as a component of curriculum thinking – whether as political rhetoric or as academic discourse. The second is Conroy and Hedley's context – technological literacy and whole-language strategies.

Elsewhere, Luke (1992a) discussing and critiquing literacy, and whilst not overtly mentioning 'technological', its insertion into the text is easily imagined and highly appropriate:

The link between (technological) literacy and economic rationalism has a long, if not altogether distinguished, history …In those countries with conservative governments, educational and social policies have stressed a binary approach to literacy: 'cultural literacy' based on the Anglo-colonial literary canon for an elite… and 'functional literacy' for everyone else (i.e. 'survival' skills for the emergent underclass). (Luke, 1992a:3)

Apple addresses this phenomenon as analogous to the Victorian cotton mill workers with a highly paid elite of engineers (computer programmers), usually men, and a mass of low-paid semi-skilled loom operatives (keyboard operatives), usually women. (Apple, 1992)

Lewis & Gagel (1992) have provided a valuable exploration of some key issues and link Technological Literacy to general education and a 'curriculum more attuned to everyday concerns' and the 'day-to-day requirements of citizenship' (Lewis & Gagel, 1992:118-120). These authors alert us to the significance of technological determinism to constructs of Technological Literacy. They apply Hirsch's (1998) concept of cultural literacy and they draw on the work of another prominent literary theorist, Gee, when they argue:

Technological literacy has economic, political, moral, ethical, ecological and indeed even psychic or spiritual aspects. It implies higher-order cognitive attributes, for example problem-solving skills…

Our own position is that the study of language, science, social studies, history, mathematics, art, music, government, civics, or ethics, helps to shed light upon the nature of technology, and that concepts and understandings deriving therefrom must be considered requisite constituents of the knowledge base of the technologically literate person…

The study of technology is fundamental to the teaching of technological literacy. Hence, to further the goal of technological literacy, schools would seem to have two clear responsibilities: first, to articulate the disciplinary structure of technology and, second, to provide for its authentic expression in the curriculum. (Lewis & Gagel 1992: 135-6)

Sketches from the field of literacy

A note:
I would share at the outset of this section of the paper that I harbour concerns about the economic and political attention given to literacy per se while Technology, such a core characteristic of our very being, remains marginalised. If language is just a tool then literacy may be just a technology and 'Technological Literacy' some kind of tautology. Perhaps a doctorate could clarify this.

At the crudest of levels, there are those who construct literacy as a matter of spelling and grammar. Similarly, there are those who would confine Technological Literacy as a matter of skills and technique alone. Whatever the field, such constructs are technical and are to be easily tested, thus standards can be created by which teachers can have their performance appraised.

More subtle approaches use the language of 'awareness' of technologies and 'access' to them. However, accessing technologies and being aware of them is no guarantee of personal empowerment or choice in their use and effects. Just as Emmitt & Pollock (1991) demonstrate that 'the concept of literacy is culturally determined' so we must take a similar view of Technological Literacy and view Technology-as-cultural-practice. Instrumental constructions of literacy fail to provide full and emancipatory empowerment and are devoid of a critical dimension. These authors cite Freire's (1972) call for critical literacy, for all and not a few, where literacy is important for functioning as a human being, enabling learners to become '…more critically aware of their world and to be in creative control of it' (Emmitt & Pollock, 1991:9).

Meanwhile the New London Group (NLG) (1996) articulate their…

…twin goals for literacy learning: creating access to the evolving language of work, power, and community, and fostering the critical engagement necessary for them to design their social futures and achieve success through fulfilling employment. (NLG 1996:60)

and they observe that:
Literacy pedagogy has traditionally meant teaching and learning to read and write in page-bound, official, standard forms of the national language. Literacy pedagogy, in other words, has been a carefully restricted project – restricted to formalized, monolingual,

monocultural, and rule-governed forms of language. (NLG, 1996:60-61)

Interestingly, on their journey of deliberation of the 'state of literacy pedagogy', this group make use of the 'key concept' of 'Design' and discover that '… as designers of meaning, we are designers of social futures – workplace futures, public futures, and community futures' (NLG, 1996:65). It would seem that 'design' is gaining overdue attention in other fields! The New London Group, in moving on from 'mere literacy' advance the idea of 'multiliteracies'. Thus we might accept multiple and changing meanings of technology rather than searching for a grail articulated through a single definition.

Technological Literacy for our schools and for democratic society

As I have suggested, there is much we might learn from the literacy theorists – and from my current position, I suggest we may have some thoughts to offer them. It is a current political fact that of three key facets of our species evolution – language, thought and technology – the first is favoured and the last, (which is the only one capable of embodying the other two) is educationally marginalised.

In offering some pointers for Technology educators I draw on the work of Lankshear (1998) and Comber (1992, 1994 and, et al., 1998). Both authors illuminate some key concepts which serve Technology well.

Lankshear (1998:45) contends that literacy '& must be seen & as having three interlocking dimensions and that an integrated pedagogy addresses all three simultaneously and none holds any priority over the others. Thus:

- the operational – the 'means' of literacy, competency with regard to the language system
- the cultural – the 'meaning aspect of literacy' – a matter of understanding texts in relation to contexts
- the critical – concerning the socially constructed nature of all human practices and meaning systems but, further, is about empowering learners to 'transform and actively produce' the very practices themselves.

Thus the learner is the centre of (technological) literacy pedagogy rather than a mere 'recipient' of it. Lankshear (1998:47) cautions that, if pedagogical approaches aren't addressed, we may '…contribute to entrenching a highly stratified literate population'. He identifies four 'constructions of literacy' which have emerged in policy formulations and I apply the technological slant to these here.

- Lingering basics: fundamentals, basic skills and techniques which are generalisable for diagnosis, validation and accountability purposes. Skills for industry
- New basics: let's raise the old base to critical thinking, design skills, problem-solving
- Multi-skilling for industry
- Elite literacies: technological literacy for elites such as designers, engineers, programmers, etc
- (Foreign language literacy: a form of elite literacy with no apparent technological equivalent.)

In addressing critical literacy Comber's (1994) work is illuminating. (Here I insert technologies (for texts) and technological in front of 'literacies'.

In this view of critical literacy the teacher's role is to help generate discourse critique as part of the critique of ways of reading the world.

Problematising classroom and popular texts (technologies) offers immediate potential to all teachers as a first step in a critical (technological) literacy curriculum. Students become conscious of the ways in which texts (technologies) operate to construct the worlds in which they live. From teachers' and students' points of view it means learning to ask new questions, questions which alert us to the insight that (technological) literacy is not a single neutral state but that there are multiple (technological) literacies, and not all of these are liberating. (Comber, 1994:665-6)

How shall our garden grow?

If our intention is to (mass) produce a crop of students as fodder for the economy and who are politically compliant then we might design on unproblematised curriculum of lingering technological basics. We must then take a minimalist position and construct Technological Literacy as a single, instrumental and reductionist literacy which can be readily tested and, with this, our own performance can be appraised.

However, we might also construct a Technological Literacy which serves to empower Technology Education itself. We could refute the technical-instrumental and develop the critical, the problematised, even Technological Literacies with multiple meanings where the ideological and the political are explicit. Perhaps we might design curriculum and pedagogy that are critical – emancipatory in nature and have the student and democracy as their core concerns. The problem with that, of course, is that we may end up providing myriad wild varieties whose blooms might serve to enrich our societies.

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Footnote

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- Jack Mundy, Australian political and environmental activist, without the likes of whose critical approach, democratic life would wither, and who kept me from finishing this piece when it should have been.

Structuring Innovation-Orientated Approaches to Teaching Technology

College of Education Erfurt. Institut of Technical Science and Company's Development
Nordhäuser Str. 63, D – 99089 Erfurt, Germany
Bernd Hill and Manfred Lutherdt

Introduction

The paper seeks to indicate how an innovation orientated approach to teaching technology can be structured. A range of strategies are discussed and suggestions made for implementation.

1 Setting the context

Technology as the physical manifestation of human creativity is an important part of human culture. Just as technology shapes and penetrates all aspects of human life, the relationships between human-beings and their technology are correspondingly multifarious. Technology manifests itself in the form of technical systems and within the unity of function-fulfilling structures such as development, manufacturing and utilisation processes, i.e. in the form of structure and process. Thus, both forms of manifestation must be reflected in the teaching of technology.

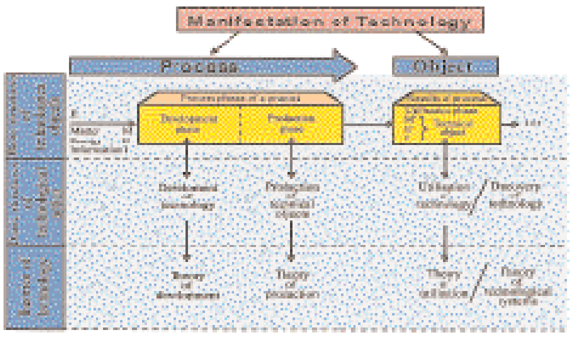

Figure 1 Manifestations of Technology and their Didactic Relationships

Technology is not something external to human beings, but an expression of their creative ability (1, P. 5) and the result is the manifestation of a problem solving process (2, p. 18).

The reflective nature of technology becomes clear in the teaching of technology by linking these two concepts together. In such teaching, its reflection must give particular emphasis to the processing aspect, giving the pupils hands-on experience of technological problem-solving. Consequently, the emphasis must be placed on imparting the ability to grasp the theory and to cope with the practicalities of a world dominated by technology.

This means that our technical training is directed towards developing creative ability in the direction of changing the current and future technology. The ability to innovate therefore becomes a basic principle of life in the technological world and is the prerequisite for human creative ability.

The current environmental problems caused by the negative effects of technology require an urgent answer to the question: how can technology be reshaped to harmonise with nature and so be able to guarantee a minimum level of prosperity and quality of life in the future? The answer can only lie in conceiving a technology which learns from nature, which conforms to the laws of systems and evolution, and which orientates itself towards the efficient principles of function, structure and organisation which have developed over millions of years.

The process of developing technology requires an optimal anticipation of the new combined with human creativity, in which invention is the dominant component. The significance of invention is as a creative, productive process and it is one of the oldest human activities.

If culture is defined as that which distinguishes the human being from the other animals, and on the basis that each and every culture has only been created and developed through inventions, then it can be concluded that pre-humans only became human through inventions, and that every higher development can only be achieved through the corresponding inventions.

A comprehensive understanding of technology lay special emphasis on this invention process, as a process of recognising and solving problems. This process is needed in order to be make technological design possible, and to create the corresponding prerequisites for the manufacture and utilisation of technology.

This is connected with developmental thinking, which is particularly suitable for the development and expression of technical creativity in all its forms.

2 Characteristics of the Innovation-Orientated Approach

The didactics of teaching innovation-orientated technology take the concepts of multiple-perspective, historic-genetic, general-technological and vocationally-orientated technology teaching into account while emphasising the development aspect. To this extent, the innovation-orientated approach is focused on the process phases in the presence of a product, from which one can derive the basic methodological structures as relevant tools for recognising, developing, producing and utilising technology.

Technological development requires both current and future technology to be consciously moulded and directed according to criteria of human, social and ecological acceptability, which should culminate in a harmonisation of the reciprocal relationships between human – technology – nature.

Primacy is given to independent and original management of real-life situations involving technology by looking at the problem from a basically technological viewpoint, in order to achieve creative competence which aims at bringing technology into harmony with nature within the processes of development, manufacture and utilisation.

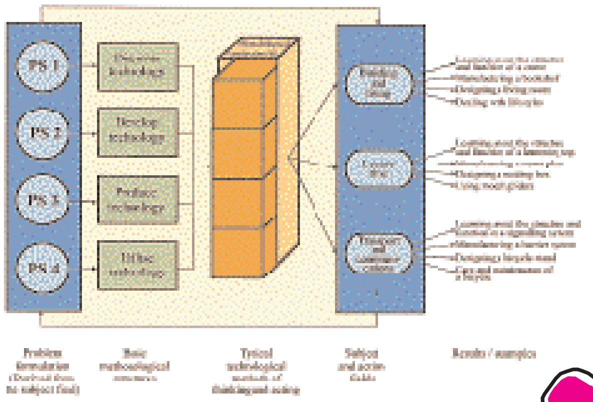

Figure 2 Presentation Strategies in the Handycaft

From this point of view, technology becomes a complex subject to learn, as it includes the multiplicity of system relationships.

The technical sciences, in particular: design, the theory of invention, system theory and synergetics, ecology and bionics all serve the basic sciences. When these technical sciences are appropriately reduced to a particular pedagogical form, they can aid pupil orientation within the world of technology. They are, amongst other things, the basis and prerequisite for understanding the theory.

Everyday technological situations, which the schoolchild is likely to meet and have to deal with, can be utilised as the starting point for the active acquisition of the technical approach to problems. The orientation towards action and problems is also aimed at coping with the technological world in a practical manner.

This includes the creative intentions of technology. Technology is not something with a pre-determined destiny, but something that we can create ourselves through our vision. The prerequisite for creating technology is the acquisition of developmental thinking.

This way of thinking is creative, because it is directed towards the subjective and objective production of new technological solutions.

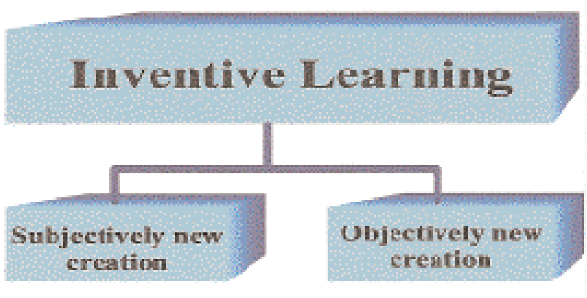

Figure 3 Two Forms of Inventive Learning

It presupposes the following contentions:

- Technology represents a compromise between conflicting factors because of its multiplicity of relationships (multi-dimensionality);
  "technology can therefore be defined as human action with the aim of reconciling what is possible under the laws of science with what is economically / ecologically reasonable and what is desirable for mankind / society". (3, p. 21)
- Technology is a target-orientated activity which causes changes and, therefore, space-time structural changes, which are performed by technical actions.

In this context, it is necessary to include the factor of effectiveness, because technology simultaneously encompasses the means (problem solving process) and constitutes the ends (the idea manifested in the form of a materialised technical solution), and also because this end represents state-of-the-art technology. It is the expression of human creativity manifesting itself by creating the sequential process in the development of technology and can thus lead to the systematic and conscious recognition of the technical problem as well as its solution. When the final result of the process is taken into consideration, this can also improve the effectiveness of any technical systems by the concrete implementation of the regular development processes.

Technology is a process of development, a historic genesis leading up to the present day which also includes anticipating the future (technical change). An increasing degree of complexity and complication is a significant feature of this technology, which is a time-space system with multiple connections and nesting.

Opportunities must be created within the framework of general technical education to enable schoolchildren to create a technology working within a society, with the aim of changing or further developing it in a way which is both environmentally sustainable and suitable for human beings.

Because of this, the pupil will recognise that the world of technology is changeable. In addition it fosters the attitude that the pupils are not just left to sink or swim but can play an active part in moulding technology.

"Coping with problems induced by technology and the conscious moulding of this practical area poses a task for the future which affects everyone and can only be managed properly if everyone affected takes part" (4, p.10).

Therefore, the ability to innovate and take responsibility are factors which will influence the quality of our future, because mankind has created the technological world as it exists now and can determine how it should be in the future.

To this extent, innovative activity based on creativity plays a key role in this structuring process.

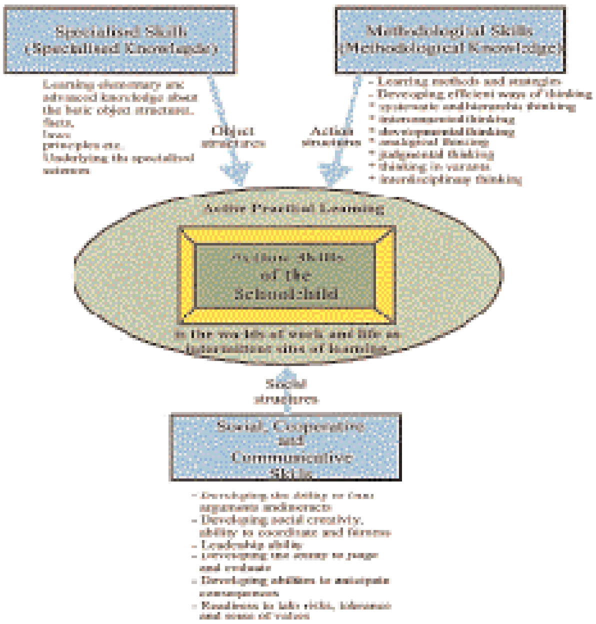

Figure 4 Developing active skills by active practical learning

Taking these statements into consideration and including the general trends in respect of the primary categories (matter, energy and information), the requirements concerning strategically directed educational concepts largely determine the pedagogical measures for preparing and orientating schoolchildren for adult life.

For this reason, it is necessary to impart the basis for interdisciplinary, developmental thinking, because technology itself must be understood as a process of development and not as an aggregate of temporally isolated structures.

Putting these ideas into practice requires learning orientation guides for the development of technology. Such orientation guides, on the basis of a generally applicable series of stages, together with typical technical methods of thinking and acting, enable problems to be recognised and solved effectively. If knowledge of these types of strategies and methods is imparted and learnt in technological teaching, then one can assume that the concrete, process-orientated learning targets derived as a result of this strategy will lead to general process-independent individual characteristics such as:

- Flexibility
- Imagination
- Problem awareness
- Ability to see analogies
- Methodicalness
- Foresight, etc.

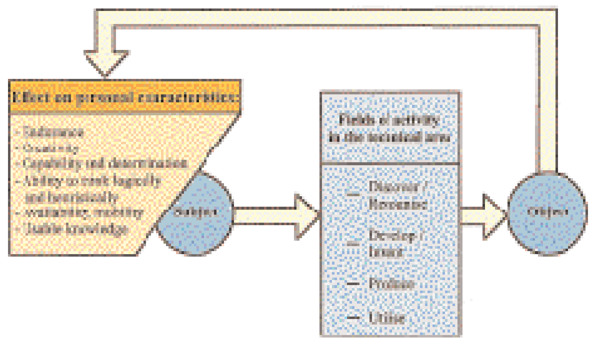

Figure 5 Subject-Object-Dialectic in the Field of Technology

Having taken these interrelations into consideration, the target-content-methods relationships can be derived.

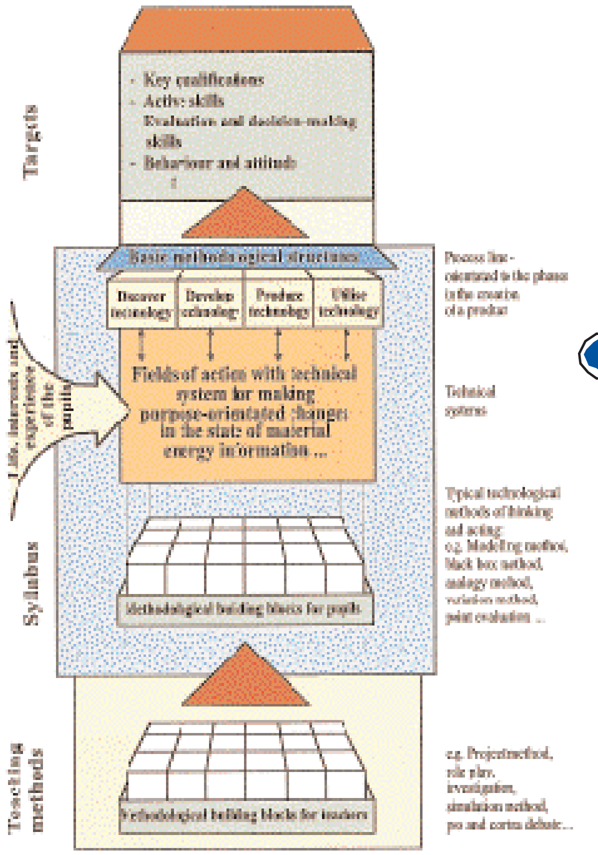

Figure 6 Target-Syllabus-Methods-Relationships of Technological Education

The material to be taught is therefore directed towards enabling the pupil to analyse the technological world in an active and creative way.

For example, if methods for recognising technical problems and solutions are to be used as subjects to be learnt, then they first need to be prepared from the didactic point of view. For instance, if it is necessary to reduce the number of stages for individual methods, then important application features are to be determined and emphasised, to assign the various methods to the respective stages in the technical problem-solving process. This means that the methods required for any single stage have to be condensed into a group of methods. These methods can be made into the "intellectual tools" of a "construction kit" which can be made available to the pupil according to classifiable criteria.

The capability of using independent methodological and performance skills has been attained if the problem solver can select methods appropriate to the specific structural features pertaining to the content of the problem situation and can put them together like building blocks to form a strategic plan of action. The result of this decision and selection process is a linear, branching classification of methods giving an operational structure to foster the development of technical activities.

3 Aims of Innovation-Orientated Technology Teaching

Based upon the features of the innovation-orientated approach which includes the diversity of the relationships between the human being and technology, the following educational aims have to be achieved in order to make them comprehensible:

- To understand technology, in the many and various forms of its manifestation, as a process of development
- To mould technology consciously and responsibly according to environmentally orientated principles and also to make it suitable for human beings
- To comprehend technology from the ecological, economic and social points of view, in its complexity and complication, as a complex event with multiple connections.

The ability to understand and change the technological world requires the acquisition of the basic patterns and the basic elements structured within technological knowledge, as well as having insight into the links which can be transferred to another context.

Therefore, the main emphasis in teaching technology must include the developmental aspect because, in the real world, technology is at the starting point of the problem solving process. The result of this process, in the form of product quality, is directly connected with the level of creativity. All the guidelines mentioned have one aspect of action in common. As the pupil becomes more independent, the development of active skills leads to the acquisition of creative abilities. Admittedly, this is a developmental process of the individual himself, who first performs quasi-creative activities which have only a receptive or reproductive character.

Developing the readiness to change the status quo requires innovative ability based on creativity. Based on the ability to make judgements and reach decisions, the development of technology as an active process requires the following:

- Looking ahead, which is displayed by setting targets
- Problem awareness, which is based on the consistent recognition and formulation of problems
- Variability, which expresses itself in alternative solutions
- Flexibility, which enables one to depart from the accustomed ways of thinking
- The ability to orientate oneself, which includes effective methods of working and forming strategies.

These desirable qualifications can only be achieved by teaching technology in a manner which conceives of technology as a mouldable element.

In this way, the teaching itself becomes action and problem orientated, it gives freedom to be creative, develops the propensity for innovativeness via productive problem solving behaviour and finally it promotes interest in technology.

SACHS characterises this type of teaching as particularly relevant for decision-making, because it includes starting points for being able to follow the line of an argument in a knowledge way and for an informed check on decisions (5, p.45).

Putting these stated aims into practice when teaching technology creates the prerequisites for being able to mould and change technology while paying attention to its multiple interrelations.

4 Aspects of the Theory of Invention as a Subject to Learn

The aims can only be achieved with a concrete syllabus content which is needed for coping with life in a technological world, and also in order to in a position to influence and shape this world creatively. In principle, the syllabus content for technological teaching can be derived from the following orientation field.

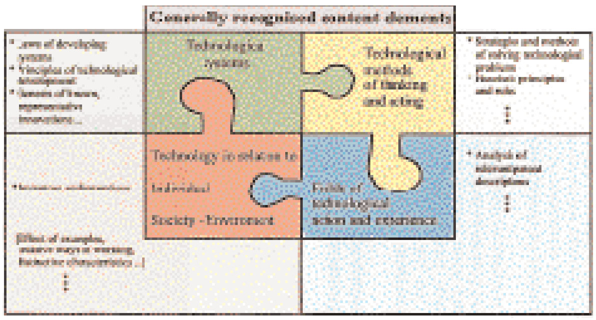

Figure 7 Content elements of Technology Lessons

Because the basic methodological structure of technology develops, describes prerequisites for production and utilisation, and particularly encourages the development of those forms of thinking and behaving which are especially relevant to the decision-making process, it raises the question: which parts of the theory of invention can be incorporated into the teaching syllabus from the specialist teaching point of view?

Invention is based upon the use of:

- The laws governing the development of market and customer requirements, social values and economic resources
- The laws governing the development of technical systems
- The laws governing the movements and developments in nature
- The laws governing the way human beings process information (6, p.27).

At the beginning of this century, Ostwald /7/, Eyth /8/, and France /9/, amongst others, concerned themselves with methodological procedures for improving the effectiveness of the inventing process. Studies by Herrig /10/, Koller /11/, Müller /12/ and Linde/Hill /13/, amongst others, analysed the structure of the course of the process to determine and solve technical development tasks by means of heuristically useful orientation models.

The theory of invention arose from the need to make inventing teachable and learnable. In this connection, findings from psychology confirm that inventing is fundamentally teachable and learnable in terms of a creative process of problem recognition and problem solution.

The prerequisite for this, amongst other considerations, is the necessary knowledge about the theory of the development of technical systems, heuristic strategies, methods and principles.

Whereby, the invariant elements of technical knowledge are particularly important. Such as those concerning:

- The subject to learn: technology (as an intermediary system for the purpose-orientated alteration of the condition of material, energy and information) related objective invariants – object structures
- The learning process: understanding technology (e.g. development, manufacture, utilisation) related subjective invariants – structures of action.

The subject to learn in technical teaching is, therefore, not only the technical system itself (WHAT), but also, and above all, the means which lead to the technical system (HOW).

The HOW reflects the general means of solving technical problems, that is, strategies and methods in connection with the laws and principles of development, which human beings have produced in order to create the organisation that ensures and improves their continued existence. To that extent, methods of invention are also methods for coping practically with technically orientated tasks which change the world.

Every technical process for the recognition and solution of problems as a means of generating function-fulfilling structures passes through the following stages:

- Abstraction and concretion
- Decomposition and composition of functional and structural characteristics.

Creative solutions are to be found in the following processes:

- Creation of analogies for stimulating associations or chains of associations
- Utilisation of the laws and principles of development as a heuristic means
- Anticipation bases on the close consideration of trends and of developing ideals
- Recognition, formulation and resolution of contradictions as a methodological tool.

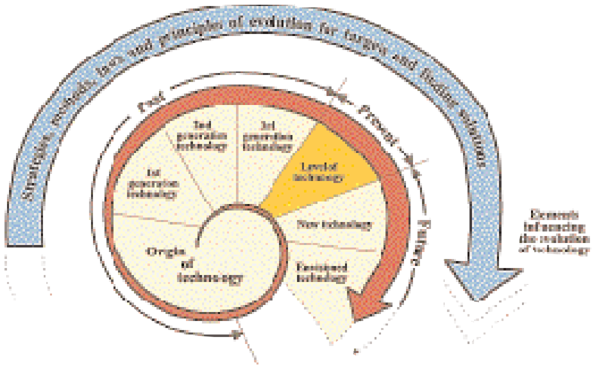

Figure 8 Evolution line of Technology

Developmental thinking requires not only knowledge about suitable methods of procedure (sequence of steps), but also additional content, that puts each step into a concrete form. An understanding of development can, therefore, only be developed in technology teaching in combination with procedures (strategies/methods) and within the laws and principles of technological development.

Awareness of knowledge and action domains important both to the individual and society is a condition prerequisite to the implementation of creative developmental thought based on a problem-solving, active approach within technical education. To this extent, such fields of actions are made comprehensible to pupils in a problem-orientated manner.

In this connection, strategies for making subjects comprehensible can be derived, as a type and method of action, which makes laws and principles comprehensible by starting from a problem situation/way of looking at a problem, and by utilising basic methodological structures together with typical technical methods (compare Figure 2).

From this point of view, technology becomes a complex subject to learn, which can only be realised in the form of a separate subject. In addition, in this subject, the knowledge gained by the pupils in other school subjects is integrated and combined with their experiences and interests. It also fosters basic competence for analysing technologically orientated situations in life. This is directly connected with the acquisition of developmental thinking.

5 Developmental Thinking as a Central Category of Technological Development

Our technological world, as an interconnected and nested system, is in a state of constant change. Not just sub-systems, whether natural or artificial, are affected, but also the relationships between them. Technology itself is a developmental process which is unceasingly driven onwards by creative technical activities. Every technical system, when considered from the technological viewpoint, is always a fleeting phenomenon. Technology appears as a process of time and space, as a developing and branching line of systems.

For this reason, the developmental thinking resulting from this is also dominated by time and space, and encompasses the historical genesis of technical phenomena, the state-of-the-art of the technology and the anticipation of its future development.

The anticipation of function fulfilling technical structures is not just an intellectual prognosis of technology but also includes speculative vision (what form could the technology of tomorrow take…?).

Developmental thinking receives feedback both from the state-of-the-art of technology as well as from the anticipation of a vision of the future to the development, it is way of thinking for developing technical devices which are:

- More effective
- More environmentally compatible and
- More suitable for human beings.

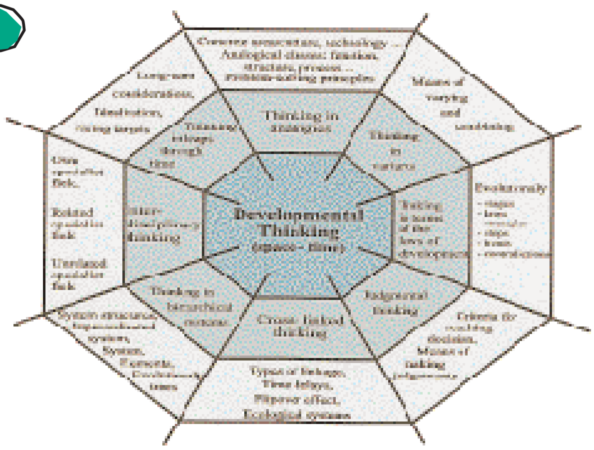

Figure 9 Developmental Thinking

Developmental thinking includes taking action when there is a conflict of aims and it is orientated towards reaching a compromise solution because it considers a problem from a multi-aspect perspective.

In addition, it includes the interdisciplinary aspect, which, amongst other things, is expressed by the constant use of biological systems as a stimulating source of ideas and the starting point for technical solutions.

This interdisciplinary aspect is expressed in the orientation function: technology makes use of functional analogies with nature.

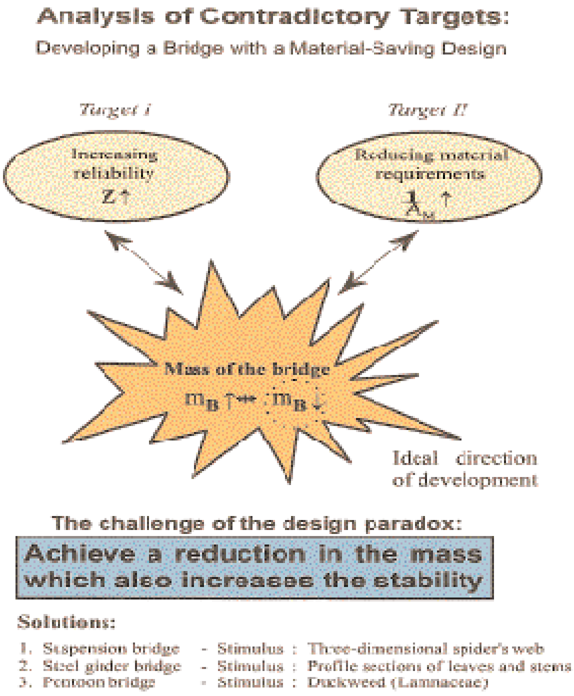

Figure 10 Nature as a source of solutions

Overcoming the contemporary concept:
"here technology, there nature" can only be achieved on the basis of broadening the understanding of technology, which includes the consideration of the interconnections between biological and technical systems. The new type of technology, which is the process of being created, is the decisive factor for this wider perspective being taken. It is orientated towards:

- The laws of biological evolution
- The principles of structure
- Function and
- Organisation of biological systems, in order to design and structure technology in such a way that it is in harmony with the biosphere.

Under these conditions, general technological education includes the development of a systematic, interdisciplinary way of thinking, in which the conception of technology is linked with biology (bionics) and ecology, amongst other things. In this way, the schoolchildren can develop insights, which will enable them to thinking in terms of such developmental laws and principles thus protecting them from developing incorrect technical solutions. This is because, once you know the laws and principles, you will find that they recur in every case (recognition aspect) and you will also have the ability to apply this knowledge to technical developments (creative aspect).

A form of technological teaching which promotes this approach will foster the following abilities:

- The insight that the world of technology is changeable and that it can therefore be influenced
- The ability to make analogies between natural and artificial systems, in order to be able to further develop and improve existing technology by orientating it towards nature, in the sense of making it more compatible with the environment and more suited to the human being
- The ability to recognise the kind of technology which is manifested by its interdependence with societal, economic, ecological and social perspectives and by its adoption of these aspects.

Apart from that, developmental thinking creates insights into elementary developmental mechanisms, arouses curiosity and the desire to change the status quo and start anew, and it also awakens the urge to invent.

The innovation-orientated approach to technological education as an open system represents only a temporary state of affairs with regard to developments in general. Naturally, it is not possible to cover all the aspects and points of view adequately within the scope of this paper.

Initial Teacher Education for Primary Technology Education in South Australia: Innovations, Reflections and Futures

University of South Australia School of Education, Holbrooks Road, Underdale, South Australia

Telephone +618 8302 6544 Facsimile +618 8302. E-mail Denise.MacGregor@unisa.edu.au

Denise MacGregor

Introduction

This paper traces the path of one of the most substantial Technology Education components in any four year Bachelor of Education course in Australia. The Technology Education programme for pre-service teachers at the University of South Australia has been both innovative and evolutionary in nature.

1998 saw the graduation of the first cohort of students and the first four years have seen several significant developments which have influenced the programme. This paper traces the shaping of the course through the critiquing of its content, the influence of state and national policy developments, the rich relationships with practising primary school teachers and the student's own evaluations. Staffing issues have also been significant in an ongoing climate of economic constraint.

The author has taught the course since its introduction and present here the issues, dilemmas and future prospects for this vital component of quality teacher education.

Setting the context

The University of South Australia is the largest of three Universities in the State of South Australia with 25,000 students, 2,000 staff and six campuses. The University is a national leader in collaborative industry research, has been recognised nationally for the quality of its teaching and community service and has a large intake of international students. The School of Education (Underdale) offers both undergraduate and postgraduate education programmes, ranging across primary and secondary degrees, studies in adult education, religion education and technology education.

Current Course Structure

The School of Education at Underdale, offers pre-service teachers a four year degree course, titled Bachelor of Education (Junior Primary/Primary).

The course is divided into two strands:
1 Professional Studies
2 General Studies

The course consists of a 144 point load, 27 of these are accredited in the general studies option, where students can choose to enrol in Technology Education as a subject specialization. Over 100 students are currently enrolled in this innovative course. Once enrolled, students undertake six, 4.5 point subjects. Each subject is delivered during a fourteen week semester.

In addition to the subjects outlined for the General studies option, all pre-service teachers are required as part of their Professional Studies to enrol in one semester of Technology Education. In the past this foundation subject has been linked with teaching of the visual Arts (2.25 points of Technology). This year (1999) it is our intention is deliver Technology Education as a separate subject (4.5 points).

Innovation – Course History (1990-1995)

Conception and Development: Two major factors contributed to the conception and development of a Technology Education course for pre-service primary teachers at the University. The first was initiated through a close professional association which had developed between the Technology Education academic staff of the University, and Paul Shallcross, an Inspector of Schools in the United Kingdom.

During the early 1990s, several staff from the University visited England to observe and discuss the teaching of Technology Education in a number of Primary schools. The outcome of these observations and discussions was one of enthusiasm, and the seed was sown for the development of the most substantial Technology Education components in any four year Bachelor of Education course in Australia.

The second major contributory factor was the introduction of Technology Education into the Primary school curriculum in 1994. This was implemented through the South Australian Department of Education curriculum policy based on the nationally agreed documents, A Statement on Technology for Australian schools and Technology – a curriculum Profile for Australian schools. (AEC,1994 a & b)

Until this time, Technical Studies, with a focus on skill development in the use of a range of materials, had been taught in Secondary schools only. Technical Studies had evolved from a subject titled Boys Craft, that was taught in Australian Secondary schools in the 1940s and the 1950s. This subject was aimed at preparing boys to enter a trade once they had completed school.

The description of Technology Education as provided to Secondary and Primary educators in the Technology Statement and Profile was holistic in nature and challenged many beliefs from the past.

Technology involves the purposeful application of knowledge, experience and resources to create products that meet human needs. Technology contributes to cultural, social, environmental and economic changes. People need to understand Technology, be confident and capable users of a wide range of Technological applications and processes, and to critically appreciate the consequences of Technological innovation. (AEC, 1994 pg., 3)

The vision held by the Technology Education staff at the University of South Australia, was for a new direction for the teaching of Technology Education at Primary, Secondary and University levels. The direction was one which embraced the changes observed in overseas trends and reflected those embedded in the introduction of the Technology Statement and Profile into Australian schools.

Thus the introduction of the National Technology Statement and Profile in 1994 provided the University with both the need and the rationale to develop a primary Technology Education course, as all teachers in Department of Education primary schools were required to teach Technology Education for the first time. University staff also recognised that introducing Technology Education at a Primary level would add impetus and validity to support the need for change at a secondary level.

Consequently, an initial aim was to prepare students who would become effective Technology Education educators as well as become strong advocates for Technology Education once they entered the Teaching profession. Furthermore, it was acknowledged that existing students should graduate with appropriate skills, knowledge and understanding associated with Technology Education which would equip them well to enter a competitive employment market.

A marketing opportunity was also evident as the University became the first to offer Bachelor of Education primary students the opportunity to specialize in Technology Education.

Influences on Course Content and Delivery: Identifying needs and successfully meeting them

University staff at the time acknowledged that their own teaching expertise was focused specifically on Secondary education programmes. As a consequence they contacted educators who were recognised as having expertise in teaching Primary Technology Education programmes at a systems level (Department of Education) and at a school level. The role of these educators, myself included, was to provide input into the design of the course and to teach the course in partnership with University educators.

A significant outcome of the teaching partnership which developed between University staff and school based educators was recognised during the planning of each of the Technology Education subjects. School based educators brought with them a wealth of knowledge of current primary technological practice and the myriad of issues related to the success or otherwise of this practice. Of significant consequence was the involvement of women for the first time, in the teaching of a Technology Education course.

Resources

University staff recognised that the teaching and learning environment which existed at the University, was Secondary focused with an emphasis on the use of machinery and reflected a particular method of teaching. Resources were directed to the development of a Primary Technology facility which would not only met the needs of pre-service teachers and University staff but would lead the way for future developments in the establishment of Technology facilities in schools throughout the Australia.

Innovative design features included:

- Provision for individual or group work at workstations or on carpeted areas
- Shadow boards equipped with tools and resources appropriate to the needs of younger children
- The addition of a range resources such as sewing machines and cooking facilities including stoves, fridges and sinks
- Provision for the storage and display of pre-service teachers work
- The use of colour to reflect a learning environment that was bright and inviting for all pre-service teachers to work in.

Professional Development

With the introduction of the Technology Statement and Profile into the Primary school curriculum came the need for in-service teacher Professional Development. Since 1993 the University in partnership with the National Professional Development Programme (NPDP), has been, and continues to be, a key provider of Professional Development in Technology Education for in-service teachers from Government and independent schools.

The opportunity to develop and maintain long term rich professional relationships with practising teachers during this time impacted greatly on the content and delivery of the courses that were offered to Technology Education pre-service teachers.

Shaped by these initial influences, the course was formalised in 1993 through the procedure of presentation to the Academic Board. The Technology Education General Studies Option was first offered to pre-service teachers in 1995 through the following subjects:

- Imagineering – creative construction: An introductory subject which aims to introduce and involve pre-service teachers in discussions, readings and experiences which facilitate an awareness of the concept of Technology, Technology Education and Technological practice. Pre-service teachers awareness of the processes of Technology is developed through a series of problem solving tasks. Through these task issues of safety, resources and skill development are addressed
- Materials for Design, Make and Appraise: This title reflects the pedagogical framework provided by the Technology Statement and Profile curriculum documents. The subject

engages pre-service teachers in school based, Design, Make and Appraise activities which develop an understanding of a wide range of materials and their properties to enable successful production of design solutions
- Technology and Us: Throughout this subject pre-service teachers reflect on how Technology interacts with culture, society and the environment. Students are encouraged to discuss and investigate the history of technological development and to explore the possible consequences of Technology at local and global levels
- Information Highways: This provides pre-service teachers with a broad understanding and an awareness of the multi-functional role that computers and associated information Technologies play in all aspects of work, education and society
- Technology by Design/Technology through Invention: This subject presents pre-service teachers with the opportunity to apply their learning to independent Technology Education projects. Pre-service teachers establish professional links with schools, industry and the wider community with the purpose of initiating and supporting change in technological practice.

Although the subjects have been presented here in a lineal sequence it is now possible for fourth year students to enrol in any of the first four Technology Education subjects as a 4.5 point elective.

Students are encouraged, through electives, to add breadth to their understanding of teaching practice in all learning areas. Although the subjects are sequential in the development of pre-service teachers skills, knowledge and understanding, the content and delivery of each subject is such that it can be studied in isolation.

Reflections, Innovations and Change 1996-1999

Staffing and Course Delivery: A major change to the delivery of the programme occurred in 1996 when the number of teaching staff reduced in numbers from seven to two. In a period of economic constraint, staff throughout the University were offered superannuation packages. The outcome of this offer contributed to a re-modelling of the staffing structure and the appointment of a P-12 Technology Education co-ordinator with one other full time lecturer.

The teaching role of the two staff members is not specific to a particular course, but areas of expertise and interest are often delivered as a team. Guest speakers, including in-service teachers, are invited to work with pre-service teachers in both secondary and primary subjects.

Through this approach the barriers that once existed between Secondary and Primary courses are being overcome. The concept of Middle schooling (years 6-10), recently introduced into South Australian schools, has also contributed to this merging of pre-service teacher groups with many secondary students enrolling in Primary subjects.

Contracted and sessional staff are employed to deliver subjects, these staff bring with them enthusiasm, new ideas and classroom experience in the teaching of Primary Technology. Issues which rise from this change are that students do not always have access to teaching staff who were not on campus full time. Planning for subjects is at times short term, as the opportunity for review and change becomes difficult when staff do not meet on a regular basis.

Changes to the Technology Education Building

Initial changes made in response to the introduction of the primary Technology Education course have continued throughout the building. Learning environments which reflect those found in schools from P-12 have been developed. Learning areas combine a range of resources, for example the senior secondary area contains sewing machines, bandsaw, drill press, lathes, work benches, computers and carpeted areas. The tasks that students are set encourage the use of a range of these resources and associated materials.

Display areas throughout the building enhance the learning environment, and add to further develop the concept of Technology Education in a visual dimension. The number of people who use the building has increased. The purpose for its use is varied including programmes for Honours students, Religious studies, Visual Arts and Research development.

Promoting Technology Education

The academic staff are pro-active in promoting Technology Education to the wider educational community through in-service programmes, consultancy and links with professional associations.

In recent years the University of South Australia has also developed a collaborative relationship with the Department of Education, (Keirl & King, 1998). The outcomes of this collaboration have resulted in the secondment of in-service teachers to deliver primary Technology Education subjects, the development of a collaborative plan to provide in-service professional development and the convening of Technology Education forums.

Forging, and maintaining these successful partnerships with key players in the Technology Education arena has meant that University educators are in the enviable position of contributing knowledge to the wider educational community, but at the same time are being constantly exposed to new ideas and experiences.

The outcome of this double edged opportunity has been, that the University staff have been able to deliver a Primary Technology Education course that is dynamic in nature, always open to new ideas and is relevant to the needs of pre-service teachers. This professional relationship was further strengthened last year when the University of South Australia held the First Primary National Conference for the Technology Learning area. As part of their fourth year of study, students presented very well received workshops at this conference.

Reflection on Course Content

The involvement of pre-service teachers in programmes to support the University's commitment to community service has continued to grow. First year students plan and present units of work to groups of primary students who regularly visit the Technology Education building. Third and fourth year students plan and present sessions to whole classes. During this time in-service teachers are able to observe a number of Technology lessons being taught, with the purpose of building on the outcomes of these sessions in their own school. Children are able to use a range of resources and visit a University, often for the first time. Pre-service teachers comment on the effectiveness of these sessions in facilitating reflection on their own understandings and technological practice.

The establishment of a strong network of educational and industrial links has facilitated a breath of content to each subject. The outcome of these links have included, site visits to industries to view technological systems in operation, input from organisations such as the ecologically sustainable development team to encourage students to critique the use of technologies and speakers from Tauondi Aboriginal college to explain the use of traditional Aboriginal technologies.

The course has continued to reflect current classroom practice. For example assessment practices such as peer appraisal and peer assessment have been implemented throughout courses. In some instances students develop their own assessment criteria. Students appreciate the opportunity to experience a process that they will be exposed to once they start teaching.

Student Evaluations

1998 saw the graduation and of the first cohort of students enrolled in the Primary Technology Education General Studies Option. As part of their last assignment this cohort of students were asked to reflect upon their last four years of Technology Education study. Their responses were informative in regards to future directions for the course, they were also very supportive.

This subject has been filled with rich learning experiences, I know I now have the skills and knowledge to enable Technology to be as enjoyable and as valuable to students in schools as it has been for me. I have learned so much in Technology Education, but I am cognizant that this is only the beginning of a long journey, but it is a journey I feel ready to start.

The opportunity that this course has provided me in regards to working with other teachers has enabled my to realize that if I teach exciting and innovative technology programmes in my classroom, others will notice and catch on and I can bring about change!

The most heartening outcome for these students is that they are now all employed, some as technology specialist teachers, others as primary classroom teachers who will teach with a strong technological focus. An initial vision to develop a course that would enable pre-service teachers to become strong advocates for the Technology Education in Primary schools has become an exciting reality.

The Future

An awareness of educational trends and market demands will continue to impact on the content and delivery of this course. Increased use of computer technologies which need to be embedded throughout courses, the introduction of control technology and expansion into varied modes of delivery have been identified as some of the key directions for the future. The need to identifying and develop wider educational markets in response to demand from in-service educators is also recognised.

The long term impact that this course has and continues to have on changing educators and the general community's perceptions of Technology Education is extremely significant. The number of students who enrol in the course continues to grow each year as students recognise the educational and employment value in specializing their study in an emerging learning area.

That there is a demand, energy and commitment for Technology Education is clear. The challenge is to continue to build a range of appropriate and quality courses for in-service and pre-service teachers alike.

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Teaching designing skills at Key Stage 2: Is there a role for techniques?

Centre for Research in Primary Technology (CRIPT), Faculty of Education, University of Central England, Birmingham, England

E-mail JEMantell@aol.com

Julie Mantell – Research Student

Introduction

Teachers in England and Wales are currently required, as part of the National Curriculum, to teach designing and making skills to children from ages 5-11. Although teaching making skills has its own challenges for the non-specialist teacher of design & technology, teaching designing skills has proved equally difficult in that these skills are less tangible. Teachers have been asking questions such as, 'What do I have to teach? How can I help children to get better at designing?' Many primary teachers feel ill-equipped to teach designing skills and the most they feel they can offer is to guide children through a 'designing process'.

This paper describes some work in progress that explores the possibilities of teaching designing techniques at Key Stage 2 as a way of helping children to develop their designing skills.

Designing skills

Defining designing skills is, in itself, a topic capable of generating considerable debate. For the purposes of this paper, I will use the designing skills specified in the programmes of study for Key Stage 2 (pupils aged 7-11 years) of the Design & Technology National Curriculum (DfE/WO 1995). I have chosen this description of designing skills as it is the one that most schools in England are currently using as the basis for their planning.

In the official guidance accompanying the National Curriculum (SCAA 1995), designing skills are grouped into four categories: generating ideas and clarifying the task, developing and communicating ideas, planning, and evaluating. It is also suggested here that teachers can help children to develop a 'repertoire' of both designing and making skills through a variety of activities in design & technology. Examples are provided illustrating how designing skills can be developed through activities in which children investigate, disassemble and evaluate products, through focused practical tasks in which children learn specific skills and through complete designing and making assignments. My interest lies in how a child's 'repertoire' of designing skills might be developed by teachers at Key Stage 2.

The current situation in teaching designing skills at Key Stage 2

Inspection reports of schools in England show that the teaching of designing is still an area of weakness in design & technology. The 1994/5 and 1995/6 Inspectors' reports comment on poorly developed designing skills along with an emphasis on making skills. One possible reason for the weakness in teaching designing skills is teachers' lack of subject expertise that has been identified as a continuing cause for concern (Benson 1997). The Inspector's report for design & technology for 1996-7 highlights the problem: '… lack of subject expertise amongst most teachers remains a major concern and is the main reason for pupils' lack of progress' (OFSTED 1998). Johnsey and Baynes (1997) suggest that a unique feature of design & technology within the primary curriculum is the fact that most teachers and teacher trainers did not study the subject in the form it is today. Yet the opportunities for training in design & technology have been much reduced due to changed priorities within education policy, especially the recent focus on literacy and numeracy. This shift of emphasis has affected the nature of teachers' professional development and the amount of time spent on design & technology within primary schools.

The evidence suggests that there is much to be done in improving the teaching of designing at Key Stage 2. This work on designing techniques has arisen from the concerns referred to here, and also as a result of many discussions with teachers, who have expressed a desire to improve their understanding of designing and how they can best support children in developing designing skills.

What are 'techniques' in design & technology?

The term 'techniques' is commonly used in connection with making in design & technology. For example, the National Curriculum programme of study for Key Stage 2 (DfE/WO 1995) requires that pupils should be taught to 'select materials, tools and techniques' and 'apply additional finishing techniques appropriate to the materials being used and the purpose of the product'. At this stage, making techniques might include examples such as using flour and water batik for adding colour and pattern to fabric, using slab-work to make a container from clay and joining square section wood with card triangles. Knowledge of these techniques is useful but not sufficient in itself. Children need to develop skills and 'know-how' in order to carry out a range of techniques. Equally important, however, is the need to develop an understanding of the purposes of these techniques, how they might be adapted to suit different situations and their advantages and disadvantages in comparison with other techniques with a similar purpose.

In this way, making techniques can contribute to a child's 'repertoire' of skills and knowledge that can be drawn upon when designing and making. This repertoire tends to be developed over time although teachers can help to extend it within a single project if they approach teaching techniques in a certain way. For example, in a unit of work where children are designing and making a moving storybook, the teacher might introduce a number of different techniques for making suitable mechanisms through focused practical tasks. The children might be given an opportunity to experiment with the techniques, to give them recognisable names and to consider ways in which they might be adapted and used in the different moving pictures they are trying to make as part of their storybook. The children should be encouraged to review their work and to compare and contrast the effectiveness of the different techniques.

The term 'techniques' is less commonly used in connection with designing. However, in the official guidance written to accompany the National Curriculum (SCAA 1995), this specific reference can be found in the section on designing skills: 'They (pupils) should become familiar with techniques such as brainstorming and product analysis to generate ideas'. Would it be possible, therefore, to identify a range of designing techniques that might be appropriate to support different aspects of children's designing at this stage?

Designing techniques

Designing 'techniques' represent a particular type of knowledge or 'know-how' in designing. They are recognisable procedures that can be used when carrying out an aspect of designing, such as finding out about user's preferences, developing ideas or planning. A technique represents one way of doing something – for example, brainstorming is a technique that can be useful for generating ideas but it is not the only one. Children might use alternative techniques such as product analysis, word pictures or user stories to support them in the process of generating ideas.

A 'technique' has its own characteristics and might have its own guiding rules for the procedure involved. For example, in brainstorming you say everything you can think about an idea and an appointed scribe writes down all the ideas without question. Ideas can then be sorted and used in different ways as appropriate. Brainstorming is a useful technique for developing a pool of ideas with other people, it can be fun to do and can extend the normal boundaries of thinking to more unusual ideas.

Designing techniques could be introduced to the children by the teacher, although children themselves might have techniques to pass on to other members of the class. With experience children might be able to select from a repertoire of designing techniques as they do with making techniques. This notion is illustrated by Johnsey (1998), who uses the analogy of a toolbox, divided into compartments, to represent aspects of designing and making, such as investigating, modelling and evaluating. He suggests that teachers need to help children to develop and add to this range of strategies (my preferred term is 'techniques') in each toolbox compartment so that children learn to use them as tools in their designing and making.

Some authors refer to 'techniques' as 'strategies' (e.g. Johnsey 1998). I would draw a distinction between these two terms. I am using the term 'technique' to describe a specific procedure, a skillful or efficient way of doing something and the term 'strategy' to describe a person's deliberate game plan with reference to solving a particular problem or dealing with a particular situation.

This use of the term 'strategy' is illustrated by Roden (1997) who identifies a range of strategies used by young children in problem-solving in design & technology. The strategies she identifies are broad approaches, quite distinct from the specificity of techniques. They include examples such as personalisation, practice and identifying difficulties.

Identifying a range of designing techniques

If techniques are to be helpful in supporting children in their designing at Key Stage 2, they need to reflect the nature of children's designing at this stage. Techniques might be identified that support children in aspects of designing such as generating ideas and clarifying the task, developing and communicating ideas, planning and evaluating. They might involve different modes of expression that help children to think in different ways, such as discussing, imaging, using gestures, drawing, working with materials and writing.

Although many designing techniques might appear familiar to teachers, they are often used as teacher planned activities rather than as techniques which children are encouraged to adopt into their repertoire to use in different designing and making situations. For example a teacher might design a worksheet to use as a framework for children's thinking in an aspect of designing. Usually this would be presented as part of the designing activity with the children following the instructions to complete the task. However, I am suggesting that an opportunity has been missed here to make the technique, in this case a framework for thinking about an aspect of designing, explicit to the children, so that it might become part of their learning and over a period of time, be absorbed into their repertoire of techniques for designing.

Suitable designing techniques might emerge from a variety of sources. A natural starting point would be activities that already take place in children's designing, such as using storyboards or flowcharts for planning, making mock ups or using a comparison chart when analysing products. Some techniques might be developed from the work of everyday and professional designers. For example, Anning and Hill (1998), in their study of the relationship between designing in elementary/primary classrooms in the U.K. and Canada, mention techniques used by the professional designers involved in the study such as word pictures, 'playing with elements' to generate ideas and sketching.

Some potential designing techniques may be familiar to primary teachers from other areas of the curriculum. For example, Wray and Lewis (1997) in their work on extending literacy identify techniques such as mapping, listing and using flowcharts for re-structuring text, and Eyres (1998) describes a history project in which he used brainstorming and organiser charts when evaluating historical artefacts and storyboards for planning a video sequence. However the 'techniques' are presented here as teaching activities rather than as procedures that children might learn to use themselves and adopt into their own repertoire of techniques.

Possible implications for using designing techniques as a way of developing children's designing skills

If teachers were to introduce designing techniques to children as an element of teaching designing skills, they would need to identify suitable techniques, introduce them to the children in an appropriate context and be explicit in talking about the purposes of individual techniques and their different uses.

Designing techniques could serve a number of useful purposes in teaching designing skills. They could be used to scaffold learning, for example with the teacher working with the children to carry out a procedure together, such as using lists for planning. The teacher could use this technique in a number of different learning situations, gradually withdrawing direct support as children grow more confident in using the technique for themselves. Some techniques could be introduced to children as a way of structuring their thinking, for example using mind maps to develop their thinking about the aspects they need to consider when designing a particular product.

For techniques to be adopted as part of children's repertoire of designing skills, teachers and children would need to talk more explicitly about the processes of designing and the techniques that might be useful. There are issues surrounding children's ability to transfer learning from different situations that have yet to be fully explored. However, there is a wide recognition of the importance of helping children to develop transferable skills that are useful in general problem-solving and creative thinking (e.g. Fisher 1990, Fryer 1996). We need to find effective ways of teaching for transfer so that children can use techniques as part of their strategies for problem-solving in a variety of situations.

Conclusion

When children first enter school they already have a range of designing skills that they have developed through their everyday encounters with the world (Baynes 1992). One accepted way that the teacher can help children to improve their designing is to encourage children to practise and apply their skills in a variety of designing and making situations. In addition, I am suggesting that teachers can extend children's repertoire of skills and knowledge useful in designing, by introducing specific techniques and encouraging children to talk explicitly about the processes of designing and learning to design. Children would need support in recognising different techniques and opportunities to try them out, so that with experience they could identify distinctive characteristics of a range of techniques and use them in a variety of situations.

Evidence suggests that standards in teaching designing at Key Stage 2 need to be improved. Our understanding of designing in the primary phase needs to be developed through research and curriculum development (e.g. Chalkley and Shield 1996, Johnsey and Baynes 1997). If there is a role for techniques in developing children's designing skills, possible areas of study might include identifying suitable techniques drawing upon what we already know about children's designing, exploring the issues concerned with transferring learning from one situation to another and investigating the nature of effective teacher interventions. My own research is currently concerned with investigating how Key Stage 2 children use language to generate, develop and organise ideas in designing. This will include looking at the use of designing techniques as frameworks for children's thinking in designing.

Acknowledgments

The notion of designing techniques has been developed in conjunction with Ali Farrell and Anne Waldon. We are currently working together on producing teaching materials that identify designing techniques for use at Key Stages 2 and 3.

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Designing and Making a Four Wheeled Vehicle

St.Nicholas R.C. Primary School, Sutton Coldfield, West Midlands, England
Telephone +44 121 355 2649
Helen Marron – Deputy Headteacher

Introduction

This designing and making activity was planned for a class of 29 year 2 (6 and 7 years old) pupils. The context in which it was delivered was significant, as the teacher had no experience of teaching design and technology and the pupils had few design and making skills. Design and technology had been a neglected area of the school curriculum. A new co-ordinator had been appointed and was keen to develop a scheme of work that could be adopted by the non-specialist. This project was one of the initial stages to that end.

The designing and making project was planned to coincide with the topic 'On the Move' in the Autumn Term. Various aspects of the science work related to this theme had been covered and therefore provided a framework within which to look more specifically at wheeled vehicles.

The scheme of work outlined suggestions for focused practical tasks (FPTs), investigation, disassembly and evaluation activities (IDEAs) as well as guidance for the design and make assignment (DMA) itself, but a starting point still had to be found. Having never taught design and technology in the way it was now outlined, or indeed having never taught about wheels and axles before, the task ahead seemed rather daunting for both teacher and pupil. Starting off with something familiar and 'comfortable' seemed the sensible approach. In the best infant tradition the children were asked to bring in things from home that had wheels. The toy box was duly emptied! Axles were examined and discussed so that the children, and the teacher had an opportunity to begin to feel more at home with what seemed initially unfamiliar and technical vocabulary.

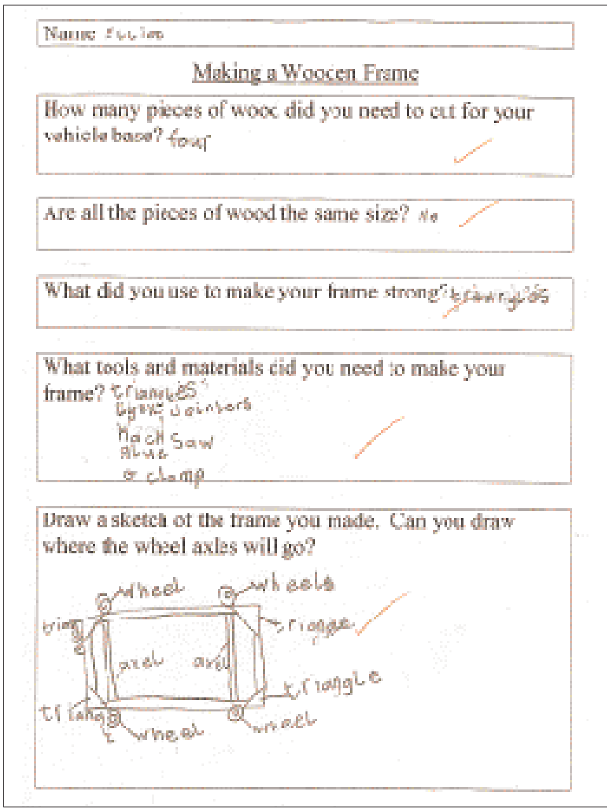
The children had been enthusiastic and responsive to the initial scene setting so on a more formal note it was decided to begin the structured work by evaluating a range of wheeled products. Actual products that could be brought into the classroom were selected in order to make the task more concrete for the children and to give them hands on experience of seeing and touching the things they were evaluating. Small groups were asked to study one vehicle in detail and relate back to the class on specific criteria. To guide the children through the evaluation stage a worksheet was prepared. This was a very useful prompt when working in unfamiliar territory. Key questions such as 'What does the vehicle have to do?' 'Is it good at doing the job it was designed for?' and 'What materials have been used?' could be incorporated. The worksheet also provided a frame for the children to record their answers.

Outline of Planning

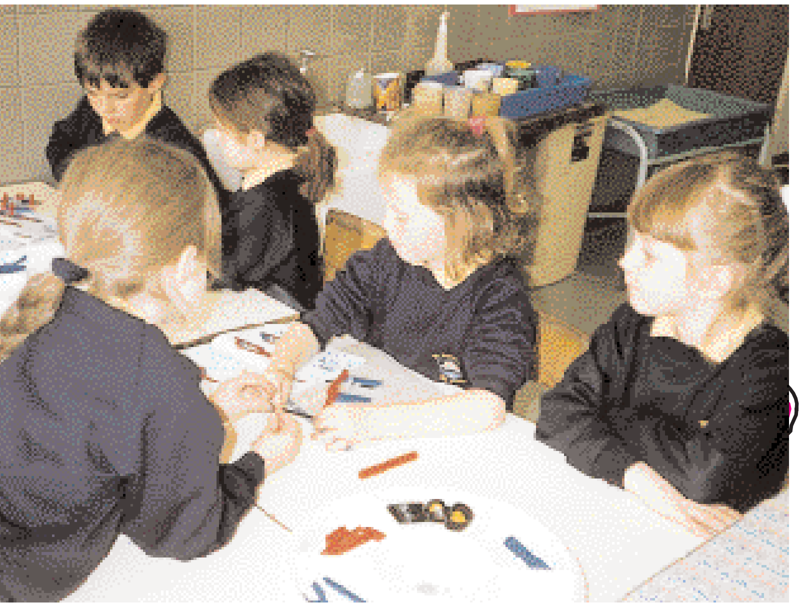
The initial scene setting had fired the children's enthusiasm. Having told the children that they would be making their own four-wheeled vehicle they expected this to happen immediately. Perhaps their own interpretation of the task involved, based on junk modelling of old, encouraged them to arrive with cereal boxes and egg cartons the next day.

It was time again to refer to the scheme of work drawn up by the post holder. The overall learning objectives for the design and technology work had been identified to develop children's:

- understanding of how wheels and axles could be used
- understanding of ways in which wheels and axles could be made
- skills in measuring, marking out and cutting
- skills in assembling materials and components
- understanding of how wheels and axles work
- understanding that vehicles (ie products) are designed to meet different needs.


Name:
Making a Wooden Frame
How many pieces of wood did you need to cut for your vehicle base? four
Are all the pieces of wood the same size?
What did you use to make your frame strong?
What tools and materials did you need to make your frame?
Draw a sketch of the frame you made. Can you draw where the wheel axles will go?

The scheme suggested focused practical tasks and investigation and disassembly ideas. Prior to the work commencing, some time had been spent discussing the tasks the children would be doing with the co-ordinator. This was a crucial first step in the planning process. Talking through the scheme of work gave us an opportunity to clarify what the learning objectives were and



the way in which the various tasks could be approached. As a result of this discussion, the way ahead appeared clearer and not quite so onerous as initially thought. Reassurance was an essential ingredient at this point.

The activities suggested in the scheme of work formed the backbone of the work that was to take place over the next few weeks. 'FPTs' and 'IDEAS' were no longer vague terms but had been translated into real tasks. Worksheets were designed both by the class teacher and the co-ordinator to guide the pupils through the work. These worksheets were a useful prop and support for the delivery of the work. Key ideas and desirable learning outcomes could be incorporated and by thinking about the content of the worksheet, the processes involved in a task could be clarified.

The scheme did not suggest an order for the tasks to be completed in, nor the method of delivery. This was down to the class teacher. It was decided to try and complete the project over half a term. This necessitated having blocked periods of the timetable. Where possible, whole class teaching was used, not only to make maximum use of time but also to maximize opportunities for questioning and sharing children's ideas. Constraints of resources and space meant that some work had to be completed in groups. All of the work took place in the classroom.

The nature of the project required the use of some specialised equipment and resources. Availability and access to what was needed was never a problem. A well organised and resourced technology area meant that the work was not hampered by lack of equipment. The tools and equipment needed was stored in sealed plastic trays that could be easily carried to the classroom and stored safely whilst working on the project.

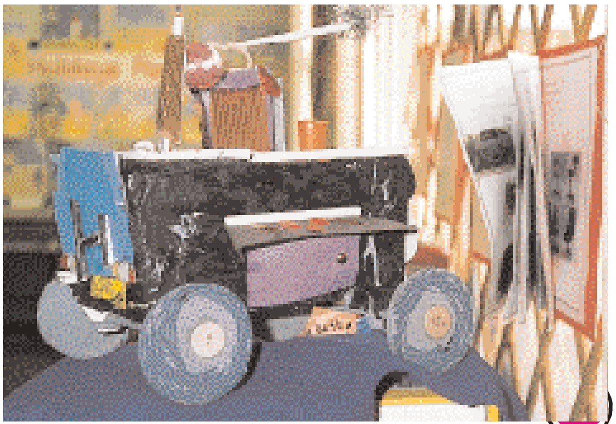
Description of the Project

Working in unfamiliar territory, it was tempting to begin with activities that appeared 'non-specialist friendly' and that drew upon familiar equipment. Hence, getting out the construction kits to deliver a specific design task, e.g. 'Build a car for a Duplo figure', didn't seem too daunting. It would have been easy however, to let such a task become undistinguished from any free play activity. What increasingly became a feature of the work was recognising the type of questions that could be asked that would focus upon aspects of the design technology work. Hence for example, the children were challenged to investigate how wheels and axles could be attached and to find out which parts moved and which were fixed. Furthermore, by organising the work into half class sessions with opportunities for a whole class plenary, ensured that the task had status and importance.

The subject co-ordinator continued to support the work once it had begun. She provided models for disassembly and supporting worksheets for the task. Disassembly activities of this nature had not been undertaken by the class teacher before. Providing resources was particularly useful and helped to guide the teacher through this learning process too.

Naturally the design and make activity required the children to be introduced to a new range of skills, tools and equipment. One of the focused practical tasks required the children to measure, mark and cut lengths of wood to make a basic frame. This task was introduced to the class as a whole by the design and technology co-ordinator. She then worked with small groups to carry out the practical task. Duly the children were shown how to use G clamps, junior hacksaws and Lynx jointers. Particular attention was given to ensuring even at this stage a quality product. Wood was sanded before gluing and methods of applying adhesive were demonstrated.

A further practical task in the scheme of work suggested providing a range of materials for the children to assemble so that they could practise attaching wheels and axles using temporary fixings. The children had a range of materials to work with, including cut lengths of dowel, pieces of plastic tubing, lolly sticks, wheels, cotton reels, masking tape and Blu-tac for joining. Of all the work covered to date, this seemed the most daunting, perhaps because of its more open-ended nature and the fact that the children rather than the teacher seemed more in control of the outcome. The children worked in pairs in half class groups. Using the wooden frames made earlier, the children



experimented. The children worked with enthusiasm and application despite encountering some of the problems of making. Listening to the children as they worked confirmed that they had learnt a tremendous amount since the project had begun. Their approach to the task was controlled and sensible. Structured activities prior to this task had clearly laid the foundations for the successful completion of this activity.

The sharing of problems associated with the task provided fruitful feedback. Reoccurring difficulties such as the wheels falling off the axles and that the wooden wheels were very hard to fit on the axles were problems the children had to try and overcome. As a follow up to the practical task the children were asked to brain-storm possible solutions for some of the problems encountered. The children worked in small groups with one child in each team nominated as a scribe. The groups then shared their ideas.

Having completed the preliminary work of the project, the next stage of designing and making could begin. The design aspect of the work was covered in whole class sessions. Thought was given to materials needed, colour, and the sequence of tasks needed to complete the work. At this stage of the work it was necessary to give some focus to sketching and labelling skills. The children referred to a variety of texts for ideas to support their design proposals. Postcards, magazine pictures, catalogues were brought into school. There were opportunities for the children to refine their designs and to move away from the notion that their first idea was the best one.

The actual making activity was organised again over a blocked period of the timetable. The nature of the activity meant that the vehicles occupied a large space of the classroom. It also seemed sensible to keep the momentum going and complete this stage of the task over a relatively short period of time. Consequently, frames were made, shoe boxes added to the frames as a basic structure and wheels were attached. Paper mache, painting and varnishing using a layer of PVA glue were applied. Throughout the work the children were encouraged to consult their the initial designs. After the basic structures were finished the children added ‘features’ such as windscreens, number plates, logos and so forth. This was a surprising element of the work. A timetable session of about an hour had been planned for but in fact the children took far longer. They did not want to be hurried. On average, each child worked for about two hours on this aspect of the project.

The completion of the vehicles did not mark the end of the project. The finished vehicles were tested along the floor and down ramps. Some repairs had to be carried out and how these faults could be avoided in the future were discussed. Of course, some time was spent admiring each other’s achievements too. In conclusion to the work, the children were asked to carry out a simple evaluation of their vehicle and the problems and successes they had encountered.

Evaluation of the Project

The quality products that the children produced, from a caravan and an ice cream van to a Polish school bus were a clear testament to the success of the project. The children were justifiably proud of their achievements. The project had generated much enthusiasm. The pupils had continued to bring in vehicles as well as information texts for the duration of the project.

The final product did not happen by chance but must be attributed to the learning process that the children had undergone. Without doubt, the key element of the project’s success was careful planning. The scheme of work drawn up by the design and technology co-ordinator was realistic and was manageable for the non-specialist.

The learning objectives had been achieved. The scheme of work only perhaps failed on one omission – and that was to warn the teacher of the fun the children were going to have!

Growing a community of good practice through a D&T curriculum development project

Nuffield Design and Technology, 28 Bedford Square, London, England, WC1B 3EG

Telephone +44 171 436 4412. E-mail jane@mitra.co.uk

Jane Mitra – Deputy Director Nuffield Primary Design & Technology Project

Introduction

The Nuffield Primary Design & Technology Project is a major UK curriculum development project, now in its third year. It is funded by the Nuffield Foundation, which is a charitable trust. The aim of the project is to give all primary teachers the chance to be brilliant at teaching design and technology (D&T). The Project includes all areas of D&T and has focussed on providing resources for teachers, on paper and in web based versions downloadable from the project website at www.nuffield.org/primaryDandT

What have we done to clarify good practice?

Our methodology is based on the importance of enabling children to make design decisions in the context of designing and making a product.

The Structure of an Activity

Example activity: **Controlling with mechanisms at KS1**

Roly Poly:

Design and make a moving toy includes:

- Possible outcomes
- Context and purpose
- The big task
- The small tasks
- The stories/ language resources
- Learning possibilities in D&T
- Children's design decisions
- How you might teach this activity
- Resources
- Important vocabulary
- Technical advice
- Learning possibilities in the wider curriculum
- Classroom management
- Assessing children's work
- Grid showing how each session meets POS for all relevant subjects

Figure 1 Structure of a Nuffield activity

We listened to teachers and teacher trainers in developing a clear teaching model – the current structure evolved from many different versions of the 'ideal' teaching model suggested by many different colleagues.

Figure 1 shows the current structure of a typical classroom activity. There are 37 activities available, across a suggested age range of 4 to 11.

The areas they cover are:

- Control
- Textiles
- Using computers
- Resistant materials
- Structures
- Products and applications
- Food technology.

What are we doing to validate our model?

We commissioned an independent research team from the Open University to scrutinise two phases of Project materials being used by teachers with their primary classes.

Teachers agreed to be recorded during lessons by the OU researchers, using radio mikes, still and video cameras, followed by interviews with teachers and pupils. There were two phases of the research:

- Phase 1 looked in general at the efficacy of the approach – this proved very useful in validating the approach, indicating areas to amend and pointing to wider applicability
- Phase 2 looked at three particular areas:
  - determining whether the amendments made were effective
  - determining the effectiveness of the activity in delivering the design and technology and related science learning objectives
  - looking at the extent to which the approach supported and fostered children's design decision making.

Figure 2 A D&T lesson being recorded

This led to a wide range of insights including:

- Clarification of the nature of the small tasks; classifying them into two broad categories – investigative and exploratory. Both types are important. Investigative small tasks are likely to be useful in helping children acquire particular knowledge, understanding and skill while exploratory tasks enable children

to become familiar with the context of the big task. This is essential for the big task to become authentic and will be particularly useful in helping children develop design ideas
- Identification of materials that would support children in making explicit their planning and design decisions – good teachers did this in response to the units
- Identification of areas where teachers need more support
- opportunities for formative assessment.

What are we doing to develop this practice in a range of primary classrooms?

Figure 3 Parents helped to make this spaghetti belt and newspaper vest

- There are over 125 schools trialling Nuffield materials
- Schools which have supplied the Project with children's work, photographs, audio clips etc. are to be featured in the Showcase section of the project website. It is planned that they will be able to upload Showcase material direct from school to the website to be moderated then published
- We are supporting clusters of schools e.g. feeder schools for Sawtry Community College where the teacher in charge of D&T is a Nuffield Area Field Officer, and groups set up and supported by local D&T Advisers e.g. in Newham, Wales, Oldham
- The Compass group, part of a Birmingham Education Business Partnership, was keen to fund INSET sessions to support local teachers interested in taking part in the Project trials – this type of partnership is a potential support community for primary schools across the country
- We have provided INSET sessions for teachers in the project, including whole school planning, practical sessions, ICT in D&T, control, mechanisms
- One trial school requested a talk for parents about the project and those attending filled in a questionnaire about their children's D&T learning and their own experiences of designing and making
- Parents have also become involved in trialling activities with their children e.g. when a class were exploring the different properties and uses of textiles, parents came into school to help make and model these 'crazy clothes' (see figure 3)
- Students at Roehampton and The Institute of Education, London, and others have started using Project materials during teaching practice in schools. They are providing valuable feedback and in the future the website Showcase will feature teaching practice achievements.

What are we doing to disseminate this good practice?

- We have compiled a Project database of over 400 schools who have requested information so far by telephone, snail mail or through the website
- Project newsletters are sent to interested teachers and relevant organisations
- An introductory Project information sheet with list of materials is available from the project centre
- The work of the project was featured in a recent TES D&T special supplement
- There is a live link to the project website from the VTC – the Virtual Teachers' Centre for teachers in England, the SVTC – the Virtual Teachers' Centre for teachers in Scotland, the National Grid for Learning and a growing number of other reference sites for teachers around the world
- The project website is featured in the TEP booklet 'Introducing the Internet in Primary Schools' sent to all primary schools during the summer term 1999
- Information about the Project is provided in the DATA National Framework publication, sent to all primary schools
- The work of the Project has been presented at a number of national and international conferences.

Who else do we involve in the work of the project and why?

It is important that we are influenced by and can have some influence upon the work of organisations and agencies involved in D&T education including:

- DfEE – Department of Education and Employment
- OFSTED – Office for Standards in Education
- QCA – Qualifications and Curriculum Authority
- DATA – Design and Technology Association

- BECTa – British Educational Communications and Technology agency
- TTA – Teacher Training Agency
- Design Council
- Engineering Council
- TEP – Technology Enhancement Programme
- RSA – The Royal Society for the encouragement of Arts Manufactures & Commerce
- A range of suppliers of D&T resources, equipment and software to schools.

How will all this grow the community of good practice?

- The work of the Project will increase communication between teachers, build confidence, celebrate success and encourage innovation
- Through the website forums they can start to engage in discussion of the issues in primary D&T, they can start to create their own agenda and can start to make their own voices heard
- Through links with teacher trainers the Nuffield approach will be available to new generations of teachers as they enter the classroom.

What evidence do we have that it's working?

- We have received largely positive feedback from teachers via the project questionnaire after trialling a classroom activity – about 75 so far
- We are encouraged by the evaluations of critical friends who have reviewed ideas, materials and project development
- Many teachers who trialled one activity are going on to do more, and some schools have built their whole school D&T plan around Nuffield activities
- We have seen teachers using the Nuffield model to teach their own choice of topic
- Our website statistics show that usage of the site is growing, and that more and more users are bookmarking our site or setting up a live link from their site to ours
- We now have a growing group of international colleagues using Project materials in Finland, Canada, Korea, Australia, New Zealand
- The appeal and robustness of the Nuffield approach to D&T is indicated by the Scottish Consultative Committee on the Curriculum working closely with the Project to develop materials for Scottish primary schools. Over a period of 9 months primary teachers from 19 schools will use the Nuffield framework to write and trial units suitable for the technology component of the Scottish Environmental Studies. The results will be edited and published jointly by Scottish CCC and Nuffield Design and Technology in Spring 2000
- In the Showcase section of the website, individual teachers and pupils are celebrating their achievements in the classroom
- The list of trial schools, called Project schools on the website, is growing all the time
- A growing list of primary D&T Consultants, Advisers and Inspectors are requesting a presence on the Project website
- The final assurance that the Project is promoting a community of good practice is from quotes like this one from a class teacher in one of our trial schools 'D&T has been wonderful this year, since we have been trialling the Nuffield material. I now know what Design and Technology actually is.'

Figure 4 Children at Stilton School evaluating their Roly Poly toys

Designing and technical constructing in early-school education

52/12 Ul, Perkuna, 04 – 180, Warsaw, Poland

Aniela Nowak – Independent Consultant

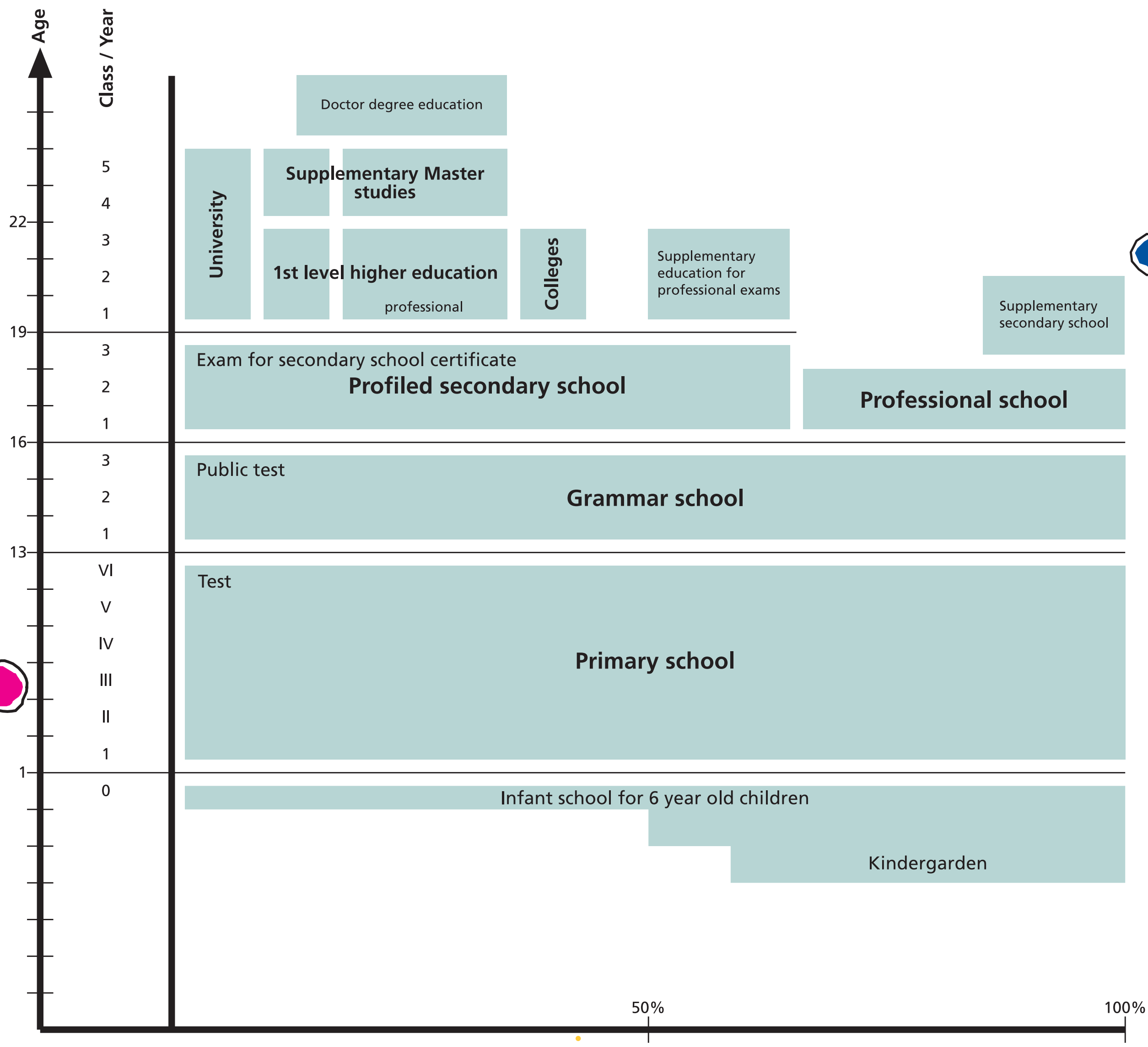
Introduction

This paper outlines the structure of the Polish educational system before considering ways in which primary aged children can gain experience of a more 'hands on approach' to learning. A selection of activities are outlined to show how this approach can be implemented in the classroom.

Setting the context

Poland has undertaken an educational reform which will be introduced on 1st September 1999. Now there is a preparing stage, especially connected with transformations concerning primary schools and the creation of public grammar-schools.

Figure 1 Scheme of education in Poland from 1999 without special education



Brief characteristics of the reformed primary school

- The primary school is a 6-year-school, at which children start learning at the age of 7 and finish at the age of 12
- In primary school there are two educational levels:
  - the first one – it is an early school education (7-9 years)
  - the second one – it is subject education in subject blocks and also educational paths of educational and didactic aspects (10-12 years).

Characteristics of the first educational level

At the first educational level there is an integrated schooling which is a mild transition from a kindergarten education to education maintained in a school system. Educational activities are conducted by a teacher according to his/her plan adjusting both the time of the lessons and breaks to suit their pupils' activities.

The educational programme at this level also contains contents relating to designing and technical activities for the pupils. Pupils also get to know how to work in selected professions, they learn how to use the everyday equipment safely, how to plan, organise stations, use materials and time rationally, or how to use such materials as paper, wood, fabric, metal, plastics, natural materials and others.

Selected examples of designing and technical constructing at the 1st level of education

I A garden swing (7 years and over / 1st class)

Pupils are to design and make a garden swing from accessible materials. While walking or playing in the garden, park or in any other place children use different equipment. They don't always think how it works, for example, a small roundabout, a chute or simply a swing. So we instruct the pupils to observe the selected equipment used for playing. We especially call pupils' attention to different types of swings or dangers connected with a swing. Children should observe what protection a swing requires to prevent excessive deflexion or inclination. Children see that swings may be hung on an axle or may be supported in the middle of the plank. We discuss with children the problem, stressing the most important parts in a swing construction.

The pupils can work in two-person-groups, talking about which swing they could make and from which materials. They draw their project on a sheet of paper, and next, in groups, they make models of their project from easily accessible materials, for example, from a rolled newspaper, sticks and others. The materials can be joined by string, staples etc.

After discussion, the designing tests with the help of the picture, and the project modelling made from simple materials, we can start to prepare the necessary materials and tools, make the plan of work to make a small swing and make the swing individually or in groups.

Aspects of designing, which are covered are through illustrations and modelling from simple materials, and by discussing with pupils the rules of how the swing works (applying of the axle) and the rules of how to play safely on a swing.

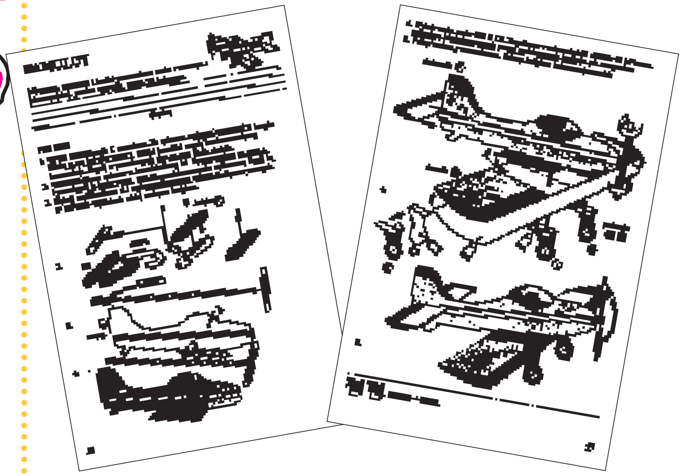
2 An Aeroplane (8 years and over, 2nd class)

The pupils should watch various aeroplanes directly or on the video film, their departures and arrivals. The talks with pupils should concern the aircraft construction. It ought to be stressed that the wheels are a very important part of an aeroplane, as they let it depart and land easily. Next, pupils watch and analyse pictures concerning the aeroplane parts (an exercise book). They think over how to construct scale model aeroplanes themselves. Together with a teacher they plan a schedule of work necessary to make it.

They also analyse what difficulties (technical or otherwise) may occur during the work. The pupils prepare their place of work (materials and tools) and make the product.

After work they tidy up their positions, evaluate their work, talk about difficulties they had and how they could be avoided. Then pupils make trials and experiences with their model. They also think about other technical solutions for the model.

Figure 2 Worksheets explaining the construction of a model aeroplane



Project review

As the result of this practical activity pupils, among others, learn about a wider use of a wheel in technics, learn names of different parts of an aeroplane, they improve their manual skills, for example cutting with scissors along straight, circular and irregular lines, gain technical experience when doing an aeroplane propeller, learn how to be precise, accurate and patient, and how to link all the elements of the airline. Besides, they also do experiments with a self-made model. The pupils use a template which is in the exercise book. Materials and tools are given by a teacher.

3 A drawbridge (3rd class; 9 years and over)

The pupils are to observe different bridges, look at them on the postcards or photos from holidays. The teacher can organise a short film to be watched. It should be linked with a presentation of a drawbridge. The pupils think over why it is necessary to build such bridges and what they were used for in the past.

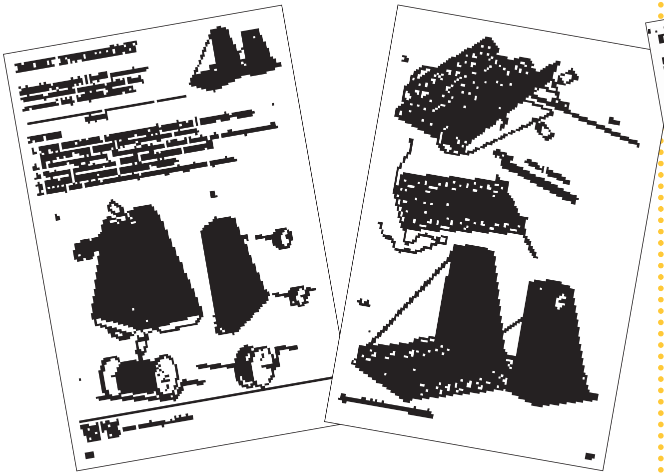
Next, we call pupils' attention to the following parts of that bridge. They learn the names of the bridge parts and ideas – shaft, axle, crank, rope and others.

They wonder what the following parts of the bridge are used for, so that the bridge could be lowered and lifted with little effort.

Then they make a plan of work, organise positions for themselves, necessary materials and tools which are provided by a teacher. The parts of the bridge are cut out from a template, which is in an exercise book.

During those activities there may occur some difficulties concerning the bending of the wire, that activity can be done by pupils with better technical experience.

Figure 3 Worksheets explaining the construction of a model drawbridge



Project review

In consequence of that technical task, pupils learn not only the parts of the drawbridge, but also how a crank, a shaft and a constant block work. The pupils should work according to the safety rules and labour legislator.

4 A crane (3rd class; 9 years and more)

The pupils should observe the work of a crane from a safe place. As far as it is possible the observation should take place during a school observation, during a school trip, or walks with parents or other adults.

The discussion should concern the construction of the cranes and their purpose. The pupils ought to observe the work of a crane and know which of the used elements in the construction of the crane make lifting of the weight easier. We point out that using constant blocks, ropes, axes, cranks and shafts the pupils should form conclusions concerning the work of a crane. It is best to carry out the task in 2, 3, or 4 person groups. The experience of more skilled pupils should be used there. Pupils less skilled can carry out tasks, which are more suited to their abilities. The activities should take place in the classroom or in a technical studio.

Materials (battens, wire, screws M3) should be provided by a teacher. Pupils, together with a teacher fix the plan of work and choose or organise such positions as: the position of cutting of the battens, the position of grinding of the batten, the position with a droller to drill holes, the position of bending and cutting wire, the fitting-up position, controlling position and others. The pupils should start their work after a detailed description of the safety rules and labour legislation, which are compulsory when making such activities.

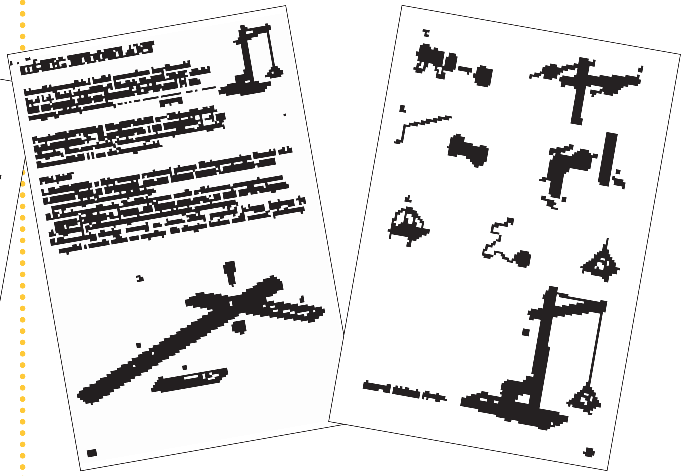


Figure 4 Worksheets explaining the construction of a model crane

Project review

When pupils make up a crane, they learn the construction of a crane, they learn about other uses of cranks, axes, shafts and ropes. They will also be able gain skills in making holes, fitting-up the crane construction with the use of nails and screws.

They will be able to look for other solutions when making.

Conclusion

The proposed technical activities do not create difficulties to be realised in Polish schools, where the manual skills of pupils are satisfactory. The tasks do not require special materials or tools. Both the teacher and the pupils must be ready to organise their positions. The teacher should provide pupils with materials such as battens, flexible thick wire, nails etc. and tools, for ex. saw, hand-drills, tongs for wire, hammers, safety equipment for the tables. The teacher should demonstrate all the technical operations, whereas pupils can work with tools only in the presence of the teacher. Everything should be discussed with the pupils and follow the safety rules and labour legislation.

The proposed technical activities teach skills about how to make simple technical operations, for example cutting out with scissors along different lines, cutting with a saw, using water stains, making holes in materials, and assembly techniques.

The aim, among others, is to prepare a pupil for an adult life, so he can understand and be able to do some basic activities for himself, his family and for others. Those activities will also help pupils learn what purpose different constructions have – axles, cranks, constant blocks, ropes, and wheels.

During the designing and making tasks, pupils improve their technical thinking and enrich their knowledge. The activities also provide opportunities to learn about different professions and respect the work of others.

Designing, technology and labour

Center for Improvement of Teachers' Qualifications

20 Fizylierôw Str, 04 – 497 Warszawa, Poland. Telephone +48 22 611 87 71

Witold Potega – Director

Translated into English by Piotr Kostôrkiewicz, M E

Introduction

The paper outlines the background to the current teaching methodologies used in Polish Primary Schools and suggests why these need to change.

A case study is included which offers an example of a possible way forward to change the philosophy of teaching in the primary classroom. The importance of active learning is recognised.

Setting the context

In 1965, being 20 years old, I began my work as a teacher. I taught a subject called technics. I worked with 15 – 19 year old students. I was not much older than most of my pupils. I decided to give up teaching traditional craftsmanship which was still obligatory in Polish schools in those days. Trying to show my best to the pupils and complying with our school curriculum, (which was pretty overloaded with theoretical matter), I decided to make them learn elements of the descriptive geometry. I still remember how my pupils were afraid of being taught such a difficult subject.

However, I was able to be really satisfied when we were dealing with designing and producing technical devices. The best and most inventive prototypes were placed on school exhibitions, some of them with explanatory notes, and even user's manuals. Amongst the most admired items at such exhibitions were often electronic projects such as power suppliers, amplifiers and generators. The most technically gifted pupils used to come to our technical laboratory after their lessons and work on their projects. In this way technics, which as a school subject had earlier often been neglected, became very interesting to pupils and to their parents. Thanks to my achievements I was appointed as a pedagogical advisor. Following 8 years of professional experience I then decided to study a higher course in pedagogics.

Apart from being a pedagogical advisor, I also helped teachers in improving their qualifications. Simultaneously I was working on some didactic projects and constructing teaching aids. Gradually my experimental interests focused on younger children. In the 1990s my work concentrated upon the role of technical exercises in developing intellectual capacity of 7 – 10 years old children. My greatest research achievement in this field was making 7 year old children able to use electrical cells, bulbs and wires in order to create electrical circuits resembling those in a hand electric torch. Besides these, the children were also able to explain basic ideas of "how it works".

Problems concerning the reform of educational work

My pedagogical experiments brought me to a conclusion often discovered by scientists before: the basis of effective learning is learners' own activeness. This principle also works in the case of 3 – 6 years old children who learn reading during an activity called 'Calling the world'. In the kindergarten that I co-operate with, children take part in many games requiring using their names, using written forms of these names and written forms of names of their activities. This way they are able to learn all the letters of our alphabet and they do not require introducing letter by letter which may be boring and has been practised as the only method of teaching the alphabet for decades, if not centuries. I would like to stress here that the very fundamental issue is children's activity, which in a natural manner stimulates the process of designing.

Here I feel obliged to explain the terms from the title of my work. Designing is according to me like foreseeing changes in the surrounding environment. These changes may be caused by some new technical appliances. Another term which should be mentioned in this context is planning. I understand planning as preparing possible ways of realizing our projects. Technology is a special way of producing particular devices, most often repeatable. Labour in this context is an important human agent. We design changes so that to meet people's needs. Designing itself is obviously also a kind of work. Labour is a way of realizing a project e.g. producing a newly invented technical device. Labour may also be fulfilling our needs with using technical devices. Labour is a way of reaching particular aims. Educational labour, performed by children, is a way of developing particular skills or, more generally, acquiring new, better patterns of living. Unfortunately many Polish teachers believe that learning should mean first of all memorizing huge amounts of information and stiff patterns of reasoning given in school handbooks. We, as the board of educational reform, have very significant problems in persuading teachers to stimulate children to learn in an active way and thus in spreading our ideas of school projects.

During the years 1996 – 1997 I participated actively in work on our school system reform conducted by the Polish Ministry of Education. From 1989 until 1999 there was a great continuous dispute over the Polish school system. The final solution has not been reached yet because all the present teachers had been "shaped" during the previous political system significantly influenced by ideology.

Schools have been set apart from the main flow of life and they still live their own life. Teachers, even those who are well qualified, are generally not very interested in the final outcome of their educational efforts. Very few teachers are really interested in students' readiness to take up useful projects that could give them a taste of real labour. The educational process is still strongly dominated by "book reading". However there are some noticable achievements, for example we were able to cancel school subjects at the level of elementary education (children 7 – 10 years old) and even more important, we cancelled the six degree marking model. This is a very encouraging symptom that the educational authorities are interested in some changes.

Up to now the main course of school life has been focused on selective marking. Links developed between school and parents were also focused on that. I do hope that cancelling the previous marking model will concentrate teachers' and parents' attention on interests and skills being developed by children. Teachers are obliged to give positive characteristic of every child. They will take interest in stimulating them to learn. Pupils want to perform activities normally performed by the grown-ups and they want to do it well. Some of those activities are labour, not only done for a living. Up to now the Polish school has been little interested in that.

Under the so called "scientific socialism" school made pupils memorize large amounts of books. Now booksellers are interested in keeping this tradition. Moreover many teachers of the older youth are glad of poor school teaching results because it helps them to earn additional money on private courses. Cancelling school selective marks (only in younger classes for the time being) is often seen by teachers as "unpleasant new" but allows the introduction of active work methods often in the field of technics and technical designing. It is important to make clear how important it is to do practicable projects at school. Now, when the Polish economy is competitive (for many people this is new) pupils see their chance in labour skills.

However, are teachers able to combine geography, history, mathematics with developing labour skills?

Designing and performing technical processes may serve here as a good example. I can prove this on the basis of my experimental research.

Experimenting

What is the subject of my current pedagogical experimenting? My students, including teachers on post-graduate courses, design, perform and analyse exercises which aims to activate children. These exercises are not traditional lessons in different school subjects but contain diversified matter, actually from all educational fields.

Let me set as an example a project done by two full-time students: Ms. Agnieszka Gierwatowska and Ms. Anna Mocarska, who were supported by Mr. Piotr Kostôrkiewicz (a post-graduate student). The project is not conventional, and apparently far from technics. It was thought as a series of lessons under a common title Poland yesterday, today and tomorrow. The main aim for this series of lessons for 12-years-old children is to bring the word Poland closer to them.

This series is to end in a rather spectacular way. At the end of it the children will perform an amateur theatrical play. This is entitled Poland is ours. During the first lesson the children will be given playscript. They will analyse it, possibly suggest some alterations, and eventually appoint actors as particular characters. Another task for them is to write a composition as an answer to a question: What does the word Poland mean to me ?

The second lesson consists of exercises which lead the whole group for a higher degree of socializing. They will do a sort of noticeboard and then use it to present their views and opinions on current facts, events and situations. First of all they are expected to say what they think about their classmates way of behaviour. On this board there should be three columns: Thank you, Congratulations, and Criticism.

In the author's view such a board could be used as a place of permanent "social communication" and a very good basis for further discussion. The aim is to make children understand that the group is like a local community and a good place to learn social life.

The third lessons require some preparation from the children. They must collect necessary information about their city, town or village, about Poland and bring it along with at least some of their sources to school. During the lessons at school they will fill in student's cards.

During the fourth lessons children will learn selected events from the Polish history, and in small "subgroups" try to put them upon the theatrical stage discussing costumes and requisites. The seventh lessons may be conducted in a form of amateur theatricals prepared and performed by children groups.

Previously, during the sixth lesson, the children will have prepared necessary requisites. Earlier, in the fifth lesson, the children will have visited museums in order to have a good opportunity to collect all of the necessary information.

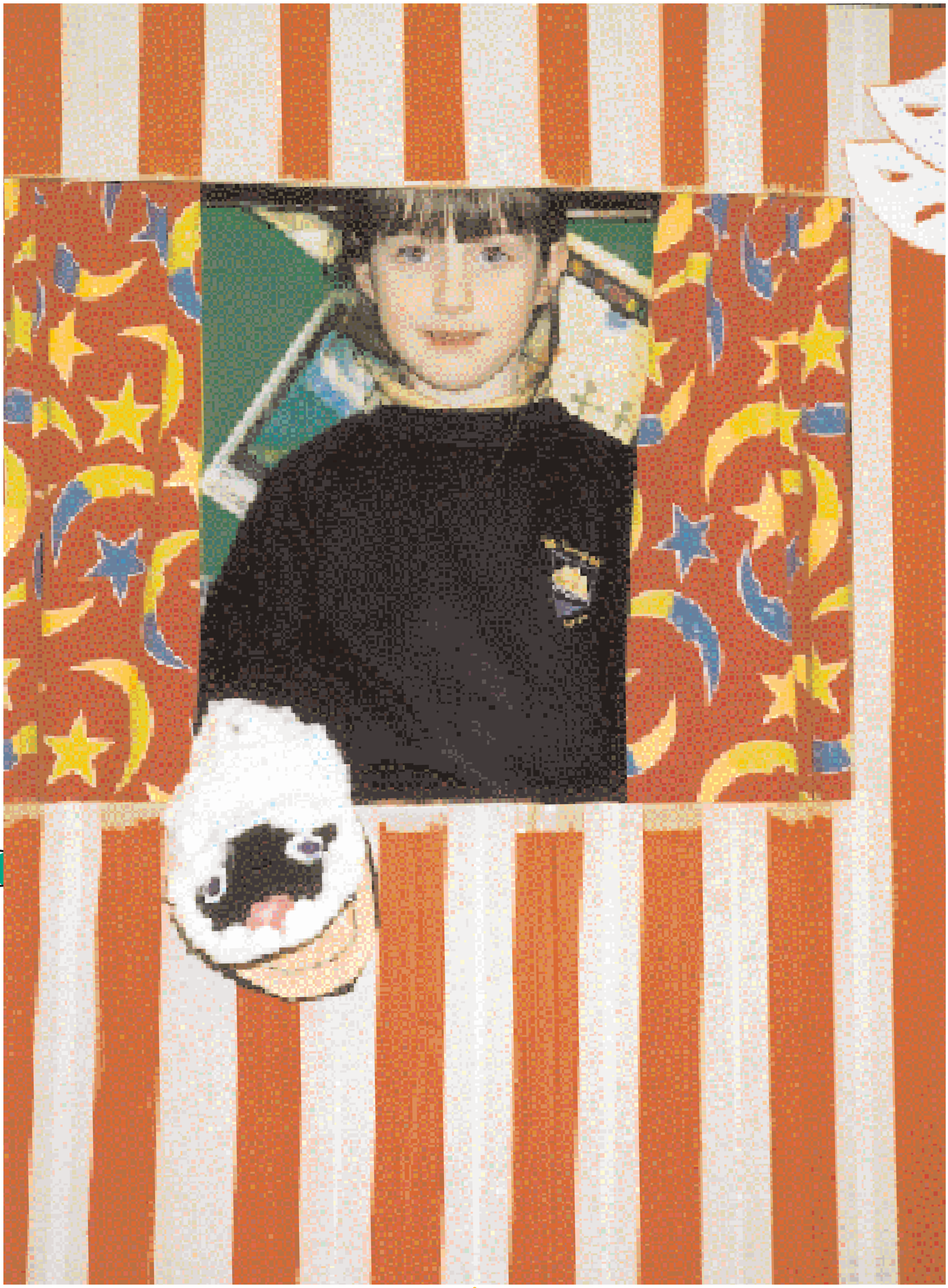
The eighth lessons may take the shape of an art exhibition on the theme of Poland today and tomorrow, in part or in full presented during the final common theatricals. These classes should include designing and producing costumes, scenography, information bills, programmes and invitations. The children ought to have these theatricals in mind all the time, preparing for them and memorizing their roles on rehearsals. The general rehearsal may be the ninth lessons. During the tenth lesson the children will present their compositions What does the word Poland mean to me? which are something like summarizing of their educational effort. They must realize at this stage that all the spectators take opportunity to watch the effects of their work and understand that their work is useful.

Designing, technics and labour are integral and inseparable elements of general education. In the example presented above children design: scripts, scenography, noticeboard, work cards, costumes, information bills, folder with information about the play, invitations… They will gain experience in using various working tools including the computer. They will develop communication skills. They can also form good customs. They will develop their interests. They will increase positive self – estimation and estimation of others' work.

Final remarks

The project above has not been put into practice yet. Moreover there are problems with realization of it in the existing teaching system (based on traditional class – lesson work method). In Poland schools are currently being re-organised. Children will attend classes for 6 years in the primary school. Will it be possible to get rid of the traditional lesson planing method? In my opinion it is crucial to remember about the significance of children's own activity, and the newly formed school system should allow for that.

In the project presented above there are opportunities to deliver all possible exercises in all possible subjects. However teachers of these traditional subjects (like Polish, mathematics, geography, etc) face a very challenging task of fitting their exercises into children's work projects. Will they be ready to do this ? Unless they do, the school will become an even more tiring and exhausting institution employing teachers and pressing children to learn by heart what their teachers know, which is unpleasant for both sides.



European Education Projects

Shawhill Primary School, Alum Rock Road, Birmingham, England. Telephone +44 121 327 2131

Beverley Peters – Design and Technology Coordinator, Partnership Coordinator, Staff Development and INSET Coordinator. Visiting lecturer at The University of Central England

Sarah Heath – Geography and History Coordinator

Introduction

SOCRATES is a European action programme which aims to develop the European dimension in education. One of its aims is to encourage contact between teachers and pupils from other countries, improving their knowledge of each others cultures and languages. This aim has been fostered through a project that three schools decided to work on in September 1997.

The title of our project was 'TASTE' – Technic Activities Together in Europe. The aim with this project was that all pupils irrespective of origin, gender or social background, will be offered the same opportunities to enhance communication and presentation in the subject of design and technology to work with computers and E-mail.

The teachers involved in the project have developed the content and pedagogical methods in design and technology with the addition of forging contacts. The project resulted in a mutual platform encouraging, motivating and providing interest for all involved.

In the project we worked with computers and E-mail to create international contacts among pupils and teachers in order to generate an ideas forum, and also to develop personal links between the participants in the three countries. Through design and technology, different subjects such as literacy, geography, science and mathematics integrate, forming a cross curricular approach.

This project promotes the European dimension and Citizenship for all children.

Participating Schools

- Ektorpsringen, Norrkoping, Sweden
- Shaw Hill Primary School, Birmingham, England
- Het Kompas, Iijmuiden, Netherlands.

Project Co-ordinator
Marie Gustaffson, Ektorpsringen, Sweden

Co-ordinators
Beverley Peters, Shaw Hill School, England
Rino Abrahamse, Het Kompas, Netherlands

Other staff involved
Gudrun Erlandsson and Bodil Norve Bengtsson, Sweden
Sarah Heath and Denise Evans, England
Lydia and Joke, Netherlands

Outline role of the project co-ordinator

- To maintain communication between the three schools
- Organising liaison between the schools in the host countries
- To ensure the project has momentum
- To collate documentation
- To plan, accomplish and evaluate the project in accordance with the aims
- To inform colleagues about outcomes of the project.

At Shaw Hill Primary School we applied to work in the field of technology (technics) and became a partner school with a further two schools: Ektorpsringen, Sweden and Het Kompas, Netherlands.

Initial visit

12th – 16th September 1997: We met in Sweden for the first time to discuss the initial plans for the continuation of the project. During this time myself and my colleague Denise Evans were able to visit Ektorpsringen school, meeting the staff and children, and we were able to make comparisons between the education systems of the two countries, together with other aspects such as the curriculum and the school's policies.

As a group we decided it would be beneficial for our children to look specifically at:

- The Design and Technology programme in our school. It was our aim that the children from the three countries involved should work on a design and make programme entitled Bridges
- The children communicating with each other through E-mail, faxing and traditional written communication. It was also the intention of our school to use the flat bed scanner which we purchased, to then send images of our design sheets to the children in the other two participating schools
- During our visit to Sweden we were able to exchange many ideas, especially in terms of the organisation of the work to be carried out by the children, and of the medium and long term plans associated with the desirable outcomes we wanted the children to experience
- The way in which the pupils from the three countries involved in the project are brought closer together, developing their learning and thinking experiences on a wider, more global scale
- Finally, how we as teachers might disseminate this experience to our colleagues working within our school's community and indeed on a broader scale, to those within the Higher Education Institutes.

Second visit

14th – 18th November 1997: We played host to schools from Sweden and the Netherlands. We now had some concrete evidence of our work and were able to compare the design sheets and the bridge constructions that the children had been working on. In evaluating the work we came to an unanimous conclusion that time was our biggest constraint. Either the demands made on us from other curriculum areas or those from the school's development plans, with reference to the resource management funds, took the most time. Unlike the other two countries, we were by far the better resourced in terms of consumable materials and support materials (eg: construction kits, teacher's resource books).

Whilst all of the participants were in the UK, we were able to visit the annual Design and Technology Show at the National Exhibition Centre in Birmingham. This provided the other schools with the opportunity to talk to representatives from companies and to view the great many products marketed for use in schools with our primary children. A few of the companies were also able to provide them with contact numbers in their own countries. More recently the Swedish schools have been able to talk to representatives in their own country about the products they saw at the show.

We decided after spending a day in our school that we needed to provide the children with more opportunities to fax and E-mail each other. This we felt could be done via the information collecting that our children would be doing in researching about our own or each others countries, the project on bridges, or the updating each other on their school calendar of events.

It was evident that the children from the participating schools requested the need to set up a 'pen pal' system which would be on-going. The children and staff in each of the three countries have greatly benefited from the artefacts that we have now begun to collect, which reflect a little of each others cultures. The visit to the Netherlands in March will mark the end of the first year of this project which has been one in which the children from England, Sweden and the Netherlands have begun to 'Bridge the Gap' between our many different cultures and education systems.

Third visit

School systems in the Netherlands were similar to ours. Again we found that all members of staff were welcoming and enthusiastic about the continuation and success of the project. We continue to share experiences and develop different ideas and perspectives.

Progress Report 1997 – 1998

This year has proved advantageous in that, in England, another member of staff, Sarah Heath, became involved, and who is especially interested in E-mail and the benefits for her Y6 class in communicating their ideas and newsletters to children within the European Community. We began the year looking at communication systems. However, the other two countries do not yet have E-mail facilities.

Design and technology (Technics) will remain the focus for the coming year. The topic on bridges has proved to be beneficial for all concerned, and has involved the children in preparing detailed design sheets to share with each other. Each year adaptations and additions are made as the staff and the children grow in skills and expertise. It is a well received topic, and one in which confidence levels have been boosted.

The children have been involved in communicating with each other through faxing and traditional letter writing, the latter being the slower method. It is our intention to involve the children in E-mailing as a far more efficient means, to train them in the use of a flat bed scanner in order to process their design sheets, display photographs of the design and make process and to display photographs of the finished pieces for each other.

The children will also be tutored in the use of E-mailing and accessing the Internet in order to gain information that will support their design and make assignments. For example we plan to investigate structures and designs for bridges around Europe and the rest of the world. They will then decide with support how they can best disseminate this information to each other.

Perhaps one of the most beneficial outcomes of this year has been the growing interest in the organisation and practices in each others' schools, and what we have to offer and learn from each other.

Major difficulties to date

- Creating sufficient time to report back to and involve all interested colleagues at school
- Insufficient funding for all the Information and Communication Technology (ICT) initiatives started. This has proved to be more problematic in Sweden.

Proposed Plans for 1999 / 2000

- We propose to involve our local Universities. For example in England we plan to link with the University of Central England to assist with tutoring children and staff in the use of E-mail, and in formulating a web page as a regular newsletter. In addition the universities will contribute their own dimensions to the project
- We intend to continue to improve the ICT standards with the extra support and additional equipment as our form of communication. These would be additional line(s) to the involved classrooms in order to make communicating viable. In England this has been aided by the National Grid for Learning (NGfL). It is also proposed to obtain additional equipment such as a video camera to aid video conferencing
- It is planned that we will receive tutoring and support in the formulation and presentation of web pages
- We will share ideas by scanning work, photographs etc produced by the children
- To continue the common theme of technology, each country will follow their own projects and share individual ideas, practices and projects on the theme of windmills
- Each country will be responsible for a presentation about their City. Children to share information eg this is Alum Rock, and then each country will make comparisons about cultures and customs etc and create a book
- We intend to share Early Years practices, themes and resource ideas with a view to improving our own experiences for young children. This still remains a deficient provision in this country in comparison with Sweden and the Netherlands.

The above mentioned projects allow each country to share individual practices and ideas. It also allows a sharing of resource lists which help the children, and indeed the staff, to appreciate the differences between the approaches to the Design and Make Activities and the final outcomes.

It is also our intention to purchase additional equipment which will further the communications systems between each country. The addition of a video camera attached to the computer will allow the children to build up and strengthen the existing links, as it is viable for the children to be involved in an exchange visit.

To conclude the year's project work, the children from the respective countries would create a newsletter/newspaper, reporting their years involvement with the project, evaluating the DMAs and methods of communication used. It is also the intention that the children would be involved in creating a Web Page depicting their school, its environment and cultures and customs.

Future intentions

Much has been learnt from this experience. Although the project finishes in February 2000, it is the intention of all the staff involved to continue the work started through this funding, with other children within our schools. The methods of communication will enhance this process as will the sharing of policies, plans and practices in the areas of design and technology, and Information and Communication Technology.

The interest created within our schools from other staff has been tremendous, and this has also forged links with the Early Years departments, who have begun to share their practices and taken a few new ones on board.

This has become a learning forum and Project Co-ordinators and Staff will continue to forge links.

Technical Contradictions, Compromises and Contradictory Solutions – Basis For A Problem-Orientated Technology Education

Institute for Technical Sciences and Operational Development, Pedagogical University Erfurt, Germany

E-mail Schmidt@ITB.PH-Erfurt.DE

Ulrich Schmidt – Diplom-ingenieur

Introduction

This paper seeks to raise issues relating to the contradictions, contradictory solutions and compromises which are part of technology education.

Technical contradictions

Technical contradictions meet us in all disciplines of technology. Let us consider their meaning, which is ascribed to them in modern technical literature, then we do not fail, if we mark them as structurally underpinning the technology and their education.

Technical contradictions initiate the development of technical systems and technology processes.

Therefore they are the basis of a problem-oriented technical education. We mark technical contradictions as structurally underpinning technology and education. The specific character and questions of their transfer into technical education should be the object of the following comments.

Technical contradictions arise first of all in the technical process of developing and shaping.

However, also in our daily contact with technology we are faced with them. They are hidden behind the variants and alternatives, from which the buyer or user of technology must choose when selecting a technical product from a broad spectrum of offers, which all fulfil the same purpose.

Examples with only one contradiction

Examples will illustrate this:

- Power tool

  The customer is offered two different models of a power tool – a device with mains circuit connection and a device with an accumulator operation. He has to choose one of them.

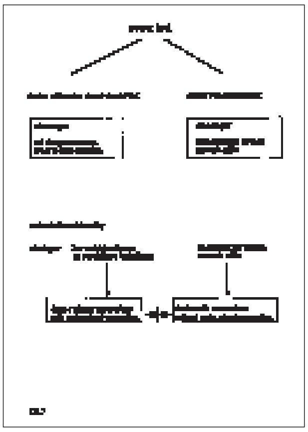


Figure 1

The customer wants to get the most from the product. The contradiction ratio between the models, leads to the fact, that with the fulfilment of the one usage-property, the fulfilment of the other is prevented and vice versa. Each model has pros and cons and that is why it represents a compromise. The buyer has to decide on one model only. At the moment an as well as is technically not possible. First one would have to find the solution to the contradiction.

In this case that would be a device, by means of which one can store a larger volume of electrical energy which is much lighter and cheaper than the traditional ones. Such a device will not be on the market in the foreseeable future.

Now three further examples:

- Electric light bulb

  The luminous power of an electric light bulb can be increased through an increase of the filament temperature.

  At the same time the service life of the product decreases due to the stronger evaporation of the filament material.

  However, both advantages, namely high luminous power and high service life, are asked for by the consumers.

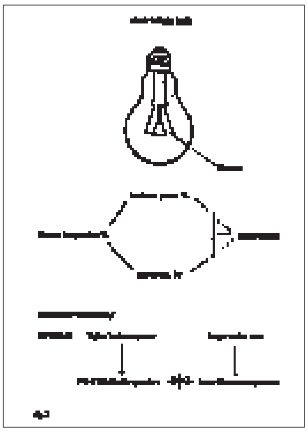


Figure 2

Here also both advantages result in paradoxical requirements. Therefore only compromises are possible.

The producer has to make a compromise with balanced concessions relating to the luminous power and the service life. This is called an optimal compromise

- Traction vehicle

  The next example originates from the mining industry.

  The traction vehicle for a track-bound train needs a high force between driving wheels and rail, to develop a high starting power.

  Normally this force is generated by the net weight of the traction vehicle which is accordingly dimensioned. The high mass of the traction vehicle which is connected with the high net weight causes an impairment of the driving dynamics of the system. Here again different compromises are possible according to usage conditions

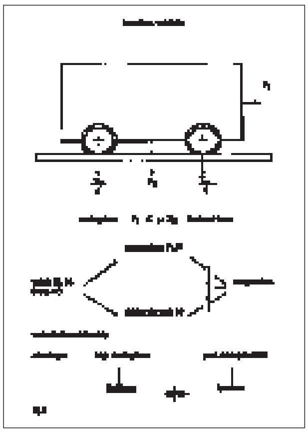


Figure 3

- Electric iron

  The next example originates from the household. The iron needs a high weight to achieve a high smoothing effect. A high mass causes an impairment of the handling dynamic.

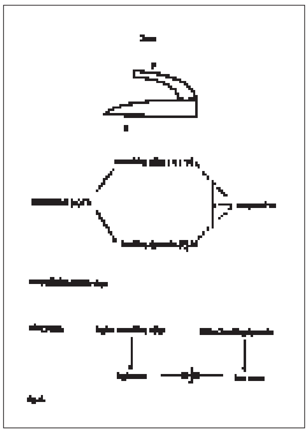


Figure 4

Both advantages require paradoxical conditions.

Examples with more than one contradiction

Up to now we have talked about products, for which only one contradiction ratio has been valid. These are the simple examples. There are also many products which unite several contradictory ratios. For example a selection of contradictory ratios of the vacuum cleaner:

• Level of surrounding noise	suction strength
• Filter volume	mass and space required
• Filter efficiency	energy needs
• Climbing ability	mass, price
• Energy needs	suction effect

Here we recognise a complex structure of contradictory ratios. The presented contradictory relations will allow a multitude of different compromises. Therefore the maker is generally trying to reach the optimal compromise and to produce the corresponding optimal model.

Making a compromise and determining the optimal compromise is a first form of the dealing with technical contradictions.

Often however the optimal compromise depends on the profile of the personal requirements of the buyer. It can be very different according to the person. The supplier best meets the different requirements of the buyer by providing the broadest possible model spectrum for selection. It contains the widest range of compromises. The buyer will try to find the variant with that compromise which is most favourable and optimal for him.

I think, one goal of the technical general education is to develop the ability of finding the model with the optimal compromise considering a broad range of contradictions.

We must remark, that despite the compromise formation, the contradiction is not solved. The acceptance of compromises only shows, that occasionally the technical contradiction is tolerated.

It exists more or less latently and as such remains an unsolved genetic problem. The competitive situation in the economy, however, exerts a constant pressure on the producer and forces him, to solve the technical contradictions.

The contradiction is only solved if a principle of solution is found, which eliminates the contradiction between the fulfilment of the properties of use. At this point, compromises are no longer necessary and the concerned properties of use can be essentially improved without mutual interference. The realisation of the contradictory solution results in the innovation of the product. By innovation the marketability of a standard product will be increased. So technical contradictions initiate technical evolution.

The solution of the contradiction will represent the innovative form of dealing with technical contradictions. To find heuristic orientations for the solution of contradictions, first of all I will show what the presented contradiction examples have in common. Here we are faced with the fatal two sides of a used property, a used phenomenon or a used effect. On the one hand, the existing requirement is fulfilled, on the other hand, however, a harmful effect can be seen. That means, that the same properties, effects or phenomena must fulfil paradoxical requirements.

Formally, such a contradiction is unsolvable, if one fails to eliminate the apparent identity of this property, this effect or this phenomenon through a corresponding differentiation. Generally this requires a very exact analysis of the contradiction.

A new viewpoint

Thereby one will recognise, that the opposite demands on the object lie on different levels, which are so closely connected with each other, that they can be considered identical according to the traditional understanding. The elimination of this identity requires a new way of viewing the problem. This new view represents the first creative step in the problem solving process.

With the electric light bulb it is the new view of the ratio evaporation – high temperature: It is possible to decrease the evaporation through the prevention of condensation despite high temperature.

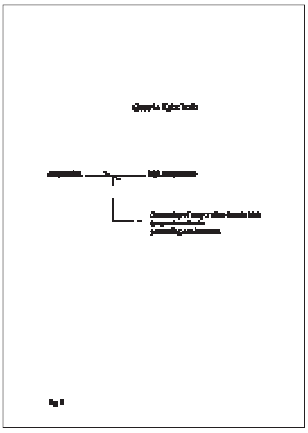


Figure 5

With the traction vehicle it is the traditional view, which connects the force of the wheels with the weight of the vehicle. This connection is not compelling and one can also increase the force (acting against) independent of the weight. This is a decoupling.

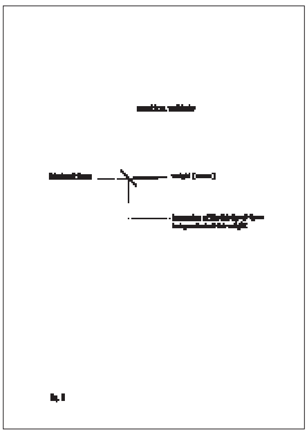


Figure 6

It is analogous with the iron.

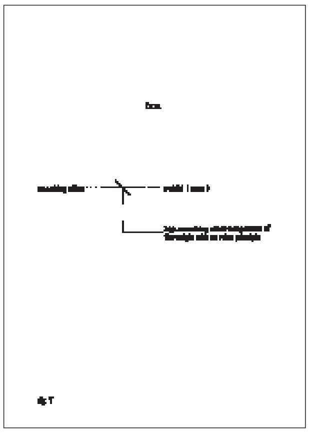


Figure 7

After the decoupling of this internal connection, one should find constructive principles, in order to fulfil the requirements independently of each other. This is, at the same time, the approach of the solution.

In the following, the solutions of our contradictions are presented:

For the electric light bulb it means, to find a principle, for decreasing the evaporation through preventing condensation. Therefore a halogen (bromine) is added to the filling gas of the lamp.

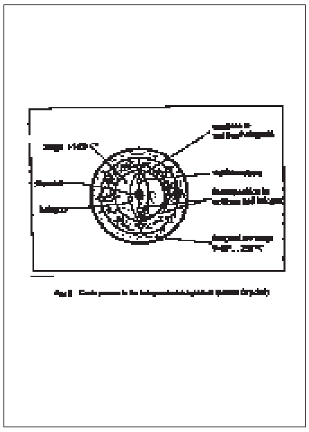


Figure 8

Together with the metal steam a chemical compound is obtained, which will no longer condense on the heated bulb walls. Near the filament however the halogen compound is greatly dissociated due to the high temperature. Through the high pressure of the metal ions near the filament, the evaporation is limited. With it the filament temperature can be enlarged and the luminous power can be increased.

Now I will discuss the traction vehicle which, in order to reach a large force between rails and wheels despite its low dead weight, an additional force has to be produced artificially. This can be done through electromagnets, which are arranged on the traction vehicle next to the rails.

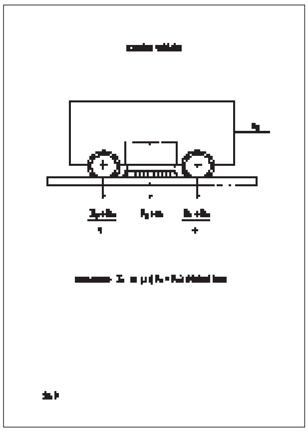


Figure 9

So its power increases the force during the starting process.

The solution approach for the Iron exists therein, that an oscillator is arranged at the bottom of the iron

Figure 10

There are no rules, which guarantee the success of the solution of a contradiction. Solved contradictions can be didactically prepared, however, so that in the education process, the procedures and attempts for the recognising and for the handling of technical contradictions can be taught.

Conclusion

Technical contradictions already play an important role in the consumer range. Generally we approach technical contradictions with compromises. From technical contradictions first of all we get a problem of optimisation. The technical contradiction directed towards a solution requires a genetic problem.

The problem solving process is more difficult; however it forms the final stage of the discussion of technical contradictions.

Thus for technical education it is important, that the pupil is sensitised for recognising technical contradictions, and that he acquires abilities for the analysis of contradictions, as well as the finding of compromises and the solving of contradictions.

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Laying the foundations of technological literacy in South Africa (the technology 2005 initiative and the implementation of technology programmes in general education)

Technology 2005, Pietermaritzburg 3200, South Africa. E-mail rodsher@iafrica.com kjter@iafrica.com

Rodney F Sherwood – National Director and Kathleen J Ter-Morshuizen – National Coordinator, Technology 2005 Project

Introduction

This paper seeks to outline the historical and present perspective in the development of primary school design and technology in South Africa.

Technology in The South African Curriculum

In June 1996 South Africa launched a new National Curriculum for all learners in the General Education and Training (GET) Band (ie: Grades 1 to 9 in schools and Levels 2 to 4 of Adult Basic Education).

The new National Curriculum makes a complete break with the past in that it:

- No longer conceptualises learning in terms of narrow academic disciplines but rather organises learning on models that are consistent with education and training in the world beyond formal education
- Seeks to develop a holistic and integrated approach to learning and teaching and
- Seeks to reorganise assessment so that learning outcomes and accreditation can be articulated between the education and training sectors.

Technology constitutes one of eight compulsory Learning Areas in the National Curriculum and, in many essential respects, is consistent with conceptions of Technology Education worldwide. It, for instance:

- Places a strong emphasis on technology as a problem solving process which, although not necessarily transferable beyond technological contexts, can be taught
- Recognises that technological design provides a context within which to integrate cognitive and manipulative skills in ways which should uniquely enhance learning
- Seeks to enhance learners understanding of the entire made environment (structures, systems and processes) and their confidence to engage with it and
- Acknowledges that technology is rooted in culture and values.

Technology therefore lends itself well to the reconceptualisation of education and training and is expected to play a significant role in:

- Changing perceptions of education and training
- Transforming the quality of teaching and learning by developing teaching methodologies which integrate thinking and practical activities through engagement in technological tasks
- Facilitating the integration of learning across Learning Areas (particularly in Science and Mathematics)
- Supporting outcomes based approaches to assessment and
- Linking school learning with work in the broader community.

However, unlike other Learning Areas in the National Curriculum, Technology has no earlier form or history of development in South African schools or Adult Basic Education programmes. Plans for its implementation therefore need to include strategies which aim to accelerate the development of specific capacities and resources that Technology lacks in comparison with other Learning Areas.

This includes developing:

- Acceptable levels of pre-service and in-service expertise among teacher educators
- Quality teacher education materials
- Acceptable levels of expertise amongst provincial Learning Support Staff (Subject Advisers)
- Adequate equipment and teacher support materials in schools and
- Well planned medium and long term strategies to retrain teachers and enhance their confidence and commitment to teaching Technology.

It is in this regard, that the Technology 2005 Project has begun to lay the foundation for the implementation of Technology in the General Education and Training Band (Grade 1-9) in South Africa.

Supporting The Implementation Of Technology In The National Curriculum: The Technology 2005 Initiative

The Focus Of Support: Phase One

The Technology 2005 Project was launched by the Heads of Provincial Education Departments Committee (HEDCOM) in October 1994 to, amongst other things:

- Develop a contextualised (relevant) understanding of Technology and
- Develop, trial and finalise contextually (ie: SA relevant) curricula and accompanying educational materials (including teacher support materials) in pilot projects.

Although piloting had not begun by the advent of the National Curriculum in 1996, the project had, by that time, reached a position where it was able to make a significant contribution to the development of national curriculum frameworks and other policy related to the new Learning Area: Technology.

Since 1996 the project has focused on working with the national and provincial education departments to support the implementation of Technology through specific initiatives. These include:

- Developing, piloting and refining teaching and learning materials capable of supporting teachers involved in the implementation of Technology Education as part of the National Curriculum

- Facilitating the development of pre-service and in-service teacher education programmes in colleges of education and supporting lecturers in the implementation of these programmes
- Developing Technology Unit Standards for Adult Basic Education and Training (ABET) Levels 2, 3 and 4 in the General Education and Training (GET) Band and
- Conducting a detailed evaluation of the project's development and implementation of Technology in pilot schools so that strategies for the wider implementation of Technology in the GET Band could be properly developed.

The 1998 schools Technology pilot

In 1998 the project piloted its teaching and learning materials in 60 schools in the provinces of KwaZulu-Natal, Western Cape and Gauteng. This was the culmination of an ten month preparation period during which the National Task Team (four persons) and nine Provincial Task Teams (approximately 2 per province) worked together to develop materials and conduct training necessary to run the pilot from Grade 1 to 9 in participating schools.

Materials development was a collaborative exercise which the National Task Team coordinated via a series of inter-provincial workshops. These also doubled up as training workshops. Teams met five times during 1997 to prepare teaching and learning materials and plan for the implementation of the materials in the pilot schools. The pace of development at these week long workshops was, however, slower than originally anticipated. Because most Provincial Task Team staff had no initial training or experience in Technology and policy documentation was still evolving throughout 1997, much of the time allowed for developing teaching material had to be given over to training.

At the end, three to four projects were developed per grade, providing sufficient activities for a year's work. Project themes were developed to National Curriculum requirements. However, there was not enough time to fully consider progression within these areas.

Initially all projects had teacher and learner guides. During the course of trialing, however, due largely to printing constraints in schools, teacher and learner guides were combined. All materials had an initial page that gave an outline of the various tasks. Teachers could, if they so chose, interpret and expand the tasks differently to the way in which they were set out in the material, as long as they maintained the given outline.

The engagement of teachers with the draft material was hoped to be the first step in a process of refining the materials to a point where they could be used as curriculum and assessment exemplars.

Despite the various limitations in the materials development process, Provincial Task Team members gained much from the process. They developed a sound common understanding of the national policy documents and the demands and nature of the new Learning Area. They also responded well to the opportunities to work collaboratively on the curriculum development initiatives and in jointly planning of the training and implementation of the project materials in the schools in their respective provinces.

The project therefore provided a unique opportunity to test the national curriculum policy on Technology against the realities of implementation.

Besides the assessment associated with the materials development process, the National Task Team felt that it was important and necessary to investigate the broader implication of assessment for the Technology Learning Area. It was felt that this was especially critical when considering that some form of national, standardised assessment might be planned for the end of Grade 9. It was therefore decided that it would be appropriate to focus our investigation at this level. In this regard, the National Task Team approached the Independent Examinations Board (IEB) and a collaborative initiative to trial a national Grade 9 examination was launched during 1998 involving 1500 candidates in 25 schools in 5 provinces. Twenty three of the schools were Technology 2005 pilot schools, the two others were private IEB schools. The IEB managed and administered the exam, whilst a member of the National Task Team acted as an examiner and moderator.

The pilot was evaluated by the Foundation for Research Development (FRD) (Mouton J 1999).

The retraining of college of education lecturers

The initial strategy of Technology 2005 has been to encourage the introduction of Pre-service education and training (PRESET) courses at colleges of education. This has been done by developing and distributing a curriculum model for PRESET and a two year support and re-training programme for lecturers based on the curriculum model. The purpose of this strategy is to establish pre-service Technology Education programmes in colleges of education as an important component of infrastructure.

The rationale for the initial emphasis on PRESET rather than In-service education and training (INSET), is twofold.

- Firstly PRESET programmes are usually comprehensive and extensive so that after one to three years teachers emerge trained in all content areas of the Technology curriculum using the most appropriate methodologies. These younger and enthusiastic teachers will be a valuable resource and an encouragement to other teachers who have been drafted to teach Technology and who, of necessity, would have only received INSET as a preparation for teaching Technology

- Secondly, alongside the establishment of two and three year PRESET courses by colleges of education, is the provision by colleges of equipped facilities and participation of selected lecturers in the support and re-training programme. In some cases the provision is minimal but most colleges utilise appropriate, existing facilities in subject departments such as art and crafts, technical, home economics and computer facilities. These colleges become suitable sites to help meet the enormous need for on-going INSET.

70 lecturers from 42 colleges representative of all nine provinces, currently participate in the re-training and support programme. Some of these colleges have yet to begin courses in Technology Education but when they do, which is likely to be in 1999, they will have trained lecturers to offer them.

The training programme consists of week-long workshops held at the Techno Centre on the campus of the Natal College of Education in Pietermaritzburg including supplementary distance material mainly providing knowledge content and assignment work undertaken by the lecturers.

So far 5 week-long workshops have been held for each of the two groups of lecturers. Consistent with the nature of Technology as a Learning Area, the programme is activity-driven.

Lecturers:

- Develop an understanding of the technological process;
- Acquire knowledge of and skills in working with a variety of materials
- Acquire knowledge and understanding of concepts in content areas
- Have opportunity to engage in open-ended Capability Tasks in which knowledge, skills and understanding are applied and
- Are made aware of attitudes, values, and the interrelationships between technology and society and the environment.

Although the 5 lecturer re-training workshops indicated above constitute only about half of the planned programme, completed training is already sufficient to enable these lecturers to provide initial INSET to teachers in the Foundation and Intermediate phases. The programme has proved very successful.

Support for the development of Technology in Adult Education

Although not a major focus, National and Provincial project staff have supported the Department of Education (national) in the development of Technology Unit Standards for Adult Basic Education and Training levels 2, 3 and 4. These Unit Standards are due for completion in 1999. The ABET Directorate has also involved project staff in the development of ABET Placement and Recognition of Prior Learning instruments in Technology and may require further assistance in the development of Technology learning programmes.

Issues and Recommendations Arising Out Of Phase One

The Technology 2005 Project was due to conclude its work on 31 March 1999. It therefore submitted a full report on its work to HEDCOM in March. This dealt with the following aspects of its work and the implications of its findings for the broader implementation of Technology in South Africa:

- The cost of equipping schools to teach Technology. The project made recommendations on minimum levels of resourcing and possible approaches to equipping schools
- A review of the work undertaken in developing teaching and learning materials for schools and the need for this work to be continued
- The need to review some aspects of National Curriculum policy regarding the Learning Area: Technology in the light of the piloting undertaken by the project
- Assessment in Technology – particularly the application of outcomes based approaches to assessment and the possible implications of setting an external examination at the end of the General Education Band (Grade 9)
- The absolutely vital need for structured and on-going plans for the training and retraining of teachers in Technology.

At the request of the Heads of Education Departments Committee (HEDCOM), plans are currently underway to extend the work of the project for a further 12 months – so that important aspects of its work can be continued.

The Nature Of Support In Phase Two

From the year 2000 onwards, the Ministry of Education intends to continue the phased implementation of the South African National Curriculum according to the following time frames:

Table 1

2000	2001	2002	2003	2004	2005
Grades 3 and 7	Grades 4 and 8	Grades 5 and 9	Grade 6	National Curriculum Review	National Curriculum Review

While the Department of Education (national) will supply training support for the phased implementation, specific additional training is needed in Technology if implementation is to be successful.

Furthermore, the number of teachers that require retraining and the limited resources available for this purpose make it impossible to supply training on a scale sufficient to keep pace with the implementation time frames.

For this reason the approach taken in the second phase will be to:

- Offer provinces support in the systematic provision of Technology training to a growing pool of lead teachers. Initially these teachers will be selected from schools identified as ready for innovation. They will receive up to 9 days training in Technology during 1999 and, in the following year will be used selectively to work with provincial support staff to extend training to other teachers. The initiative will only operate in provinces that request such support and will vary in form depending on participating provinces specific needs
- Continue the existing retraining of college lecturers and
- Support the Department of Education (national) in their on-going Technology related development initiatives in Adult Education and other sectors.

4 Beyond 2000

Once it has run its course (the extended work of the project will be concluded in March 2000), the project is expected to leave most provinces with a small group of relatively well trained lead teachers in Grades 7 (and in some cases Grade 3). These lead teachers, together with existing provincial support staff (Subject Advisers and College of Education lecturers) will then form the basic human resource upon which provinces will have to develop plans to systematically step out training to all other teachers as the implementation of the National Curriculum progresses.

In most provinces these lead teachers will constitute no more than 5% of the teachers in a Grade.

Provincial training strategies which aim to eventually provide basic Technology training to all teachers will therefore need to provide for two training thrusts:

C the systematic training of lead teachers in each Grade as implementation progresses (see Table: 1 above) and

C provision whereby lead teachers can be used to extend training to other undertrained staff in their schools and/or districts.

A ten year training plan should be developed in each province with annual targets against which progress can be measured and reviewed.

Given the extensive demands that the implementation of the National Curriculum is making on provincial management and support staff, it is recommended that departments and NGOs in this field collaborate to consider ways in which this training requirement can be satisfactorily realised.

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A year in the life of a generalist design and technology course for BA (QTS) trainee teachers

Faculty of Education, University of Central England, Westbourne Road, Edgbaston, Birmingham, England, B15 3TN

Wesley Till – Senior Lecturer, School of Mathematics, Science and Technology. E-mail wesley.till@uce.ac.uk

Vicki Lally, Gillian Lycett, Richard Nugent, and Cathryn Sherwood – First year students on the BA (with QTS) course

Introduction

The Faculty of Education at The University of Central England in Birmingham, England, (UCE), offers a four year BA with Qualified Teacher Status (QTS) for students intending to teach in the primary sector. Students attending UCE come from a wide area of the United Kingdom, although a significant number come from Birmingham and the surrounding area, known as the West Midlands.

This paper details the generalist course in design and technology which has been held at UCE between October 1998 and April 1999. Although design and technology is an option available as a specialist subject on the BA (QTS) course, all students undertake 25 hours of taught sessions of generalist design and technology during their first year. This is presently organised into 10 weekly sessions of $2^1/_2$ hours.

The contributors to this paper have at least one thing in common, in that they each joined UCE in the autumn of 1998. In September Wesley Till joined the staff as a senior lecturer, having had 24 years teaching experience which included advisory teacher posts and a deputy headship in a Staffordshire primary school. A few weeks later Vicki Lally, Gillian Lycett, Richard Nugent and Cathryn Sherwood started the BA (QTS) course as first year trainee teachers.

The generalist course for design and technology at UCE basically has two main areas of focus. The first being to raise the students own personal level of skills, knowledge and understanding within the subject. The second main area of focus is to give the students the knowledge and skills of how to plan, manage and organise the teaching of design and technology within the primary school classroom. In other words 'how to do it'.

With over 120 students starting the first year in October 1998, they were divided into 4 groups for the generalist subject teaching. The sessions for these 4 groups were organised in similar ways, although the order of the sessions varied slightly due to the availability of rooms and resources.

Although the course had been running in different formats for several years, this was to be the first time that I was to teach the course. Whilst I wanted to organise it in my own way, drawing on and making the most of my recent experience as a primary school teacher, I also wanted to build on previous programmes.

One important part of the course was to regularly update the students on the latest national situation regarding design and technology. Once again, we found ourselves in a time of change with the process of revising the National Curriculum in full swing, together with the arrival of the National Scheme of Work from The Curriculum and Qualifications Authority (QCA) expected around Christmas 1998. Whilst we wanted the students to benefit from the latest information, we were also anxious not to confuse them as they would also be getting news and information from colleagues in other subjects.

Week 1 – Introduction

Main areas of focus:

- What is design and technology? The philosophy behind the subject
- The National Curriculum: Programme of Study and Attainment Targets. I felt that it was important here to explain the 3 main activities from the national curriculum. These being investigative, disassembly and evaluative activities (IDEAs), focused practical tasks (FPTs) and design and make assignments (DMAs)
- The place of design and technology within the primary school curriculum. Links and differences with other subjects.

Much information was given in the first week as I felt that it was important and essential to set the scene. However, by its very nature design and technology is a mainly practical subject and I was anxious that the students should spend some time involved in practical activities. Consequently the second part of the afternoon was allocated to the area of paper and card engineering including levers and linkages. This allowed opportunities for the students to carry out a range of investigative, disassembly and evaluative activities (IDEAs), and focused practical tasks (FPTs). At the same time the activities enabled the students to start to become familiar with the specialist resources available.

Mechanical concepts being explored using LEGO construction kits

Investigating, disassembling and evaluating sandwiches was all part of the fun of the food session!

Subsequent weeks

From the second week onwards I decided to use a set format for the majority of the sessions. I would start by initially outlining the aims of each session, and then the first 45-60 minutes would be a mainly taught input with demonstrations and activities. Links to the National Curriculum for design and technology (and other related subjects) were highlighted. I also made the use of my collection of photographic slides to show actual examples of children involved in similar activities in class, and this enabled me to illustrate points relating to classroom management and organisation strategies.

Supporting documentation was provided for each session in order that the students had resources to use during the next 4 years.

The next 60-75 minutes would be available for the students to be involved in design and make activities relating to that week's theme. These were generally in the form of focused practical tasks (FPTs) planned to increase the students own level of skills.

Each week would conclude with an input relating to an issue associated with design and technology. Examples included assessment, using published resources, and links with other subjects. This time would also allow time for questions and a brief discussion about the afternoon's activities, particularly allowing me to reinforce how similar activities could be implemented within a school classroom situation.

Week 2

The main focus was related to construction techniques for small sectioned wood, together with an input about the safe and appropriate use of hand tools suitable for the primary classroom. The students each made a set of different joining methods for wood, which they then mounted onto card to form a teaching aid for future reference and use in the classroom.

Whilst health and safety was a common strand throughout the various aspects of the ten weeks, this session introduced the need for risk assessment and for considering strategies for avoiding injury when involved in design and technology activities in the classroom. I also identified and outlined national and local health and safety publications and documentation produced by organisations such as DATA, NAAIDT and local education authorities (LEAs).

We also spent some time discussing how to plan suitable focused practical tasks (FPTs), and how they should be used to support design and make assignments (DMAs).

Week 3

This week we looked at the area of mechanisms at Key Stage 1, and amongst other activities the students were given the task of making a teaching aid to show how different types of wheels and axles could be made using low cost and easily used components. The material focus was that of using low cost and reclaimed materials, and many students combined the activities and designed and made a model vehicle with wheels which could move when pushed or pulled.

Another focus this week was that of examining and discussing strategies for classroom management and organisation when carrying out design and technology activities in school.

Week 4

This week our focus was that of mechanisms at Key Stage 2. We used construction kits from the LEGO Technic educational range, and concepts including the use of pulleys, gears and cams were explored. To support this we looked at a range of common items incorporating similar concepts (such as hand food mixers and toys) and considered how these could be used as investigative, disassembly and evaluative activities (IDEAs).

Week 5

This time the main focus was that of electrical control, and aspects such as circuits, components and making home made switches were covered. The strong links with science were explored, and we examined how children could include low voltage electrical circuits and components into design and technology activities. For the practical activity the students were given an opportunity to make a small focused practical task to include a circuit, LED and home made switch. The use of Clipart from the computer was incorporated into the activity and students were able to make products using foamboard such as animals with eyes that light up, and maps with locations which would illuminate. Being the last week before Christmas, it was of no surprise that illuminated Christmas trees and reindeer were also quite popular!

Week 6

The main practical focus this week was structures, and the initial part of the session was spent working in pairs on activities investigating strength and stability. Different options for practical work were available, and these included making teaching aids showing brackets and shelf construction, shell structures, and the construction of model chairs.

Other aspects covered included the use of the Internet to research design and technology activities. WWW sites such as 'How stuff works' were explored.

Week 7

This week the students were given time to start to design and make their main assignment. They had been asked to design and make a model to fulfil set criteria which basically asked them to include aspects covered so far on the course. Many of the students opted to make fairground rides, although model vehicles, creatures and items of automata were also popular.

The issue covered this week was that of strategies for the assessment of design and technology activities.

Week 8

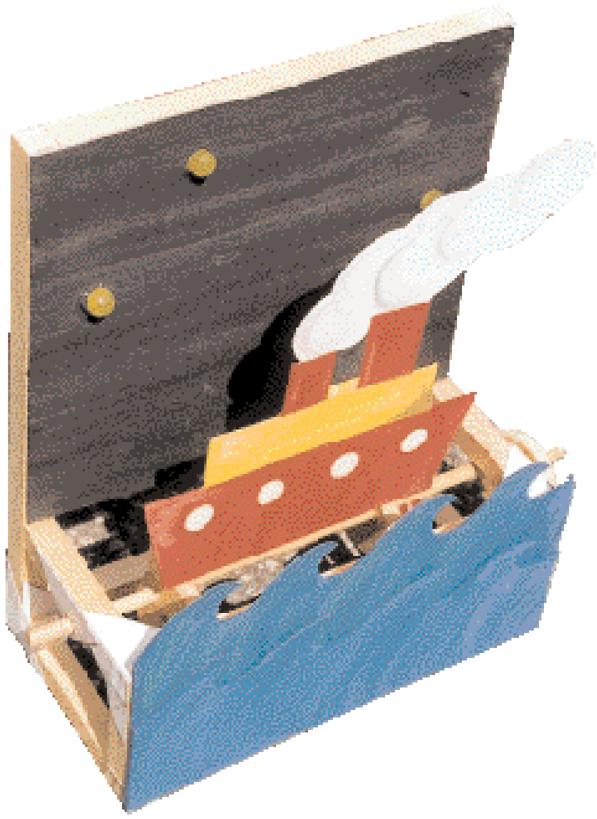
This week the theme was textiles, and the students were shown illustrated case studies of projects related to puppets and slippers activities carried out in local schools. The subsequent practical activities then included the making of a teaching aid to show different surface decoration techniques for textiles. The main design and make activity was then based around the designing and making of felt finger puppets. To provide a stand to mount them on, the students were able to construct a life-size hand from corrugated plastic.

Other aspects covered included suggestions, and points to consider when planning investigative, disassembly and evaluative activities (IDEAs).

Week 9

The main focus this week was food. For some years, UCE has developed good liaison links with the education staff from several national food organisations. For these food sessions we used the services of Judith Cartwright, who is a Regional Home Economist from The Meat and Livestock Commission. These sessions were extremely well received, not least because of Judith's very professional presentation style and excellent background subject knowledge.

Having had an initial input from Judith about issues such as nutrition and health and safety with food, the activities revolved around a design and make assignment to create a nutritionally



and areas covered during the course. This model of a ship crossing the waves features cams, structures, and an electrical circuit

balanced lunch. Firstly however, a range of commercially produced sandwiches were investigated, relevant skills were explained, and this provided a valuable link between IDEAs, FPTs and DMAs. This was particularly relevant as the activity linked in well with one of the units from The National Scheme of work for design and technology.

The activity also provided sustenance for those students who had missed out on lunch!

Week 10

As this was the final session, the students had been requested to bring in their course work for checking and assessment. There was also an opportunity for further making.

Other aspects covered included:

- Classroom management and organisation
- Considerations for teaching design and technology on teaching practice
- Published resources available for design and technology
- Latest update on the revision of The National Curriculum
- Links with Information and Communications Technology
- Course evaluation.

Next time

As with any good design and technology activity, we have constantly evaluated the course as it went along. In addition, a more formal evaluation happened in the last week for each group when the students were asked to complete a summative evaluation sheet. From the results it was very obvious that the students had thoroughly enjoyed the course, but more importantly it was equally obvious that they had found the sessions useful and beneficial to them as trainee teachers.

We invited comments about how the course could be changed in any way, and we had several very constructive and useful comments which we will certainly take into consideration when planning next year's course. For example several respondents indicated that more allocated time would be useful for the main project.

We have been closely examining the National Scheme of Work from QCA, and following its publication in December 1998 we have already built in opportunities for relevant units of work to be included in specific aspects of the course. For example the Unit on torches was used in the session on electrical control, the sandwich Unit was used in the food week, and the puppet Unit was used to support the session on textiles. We shall however look to developing further links for the next course, as we feel that it is important to give the students frequent opportunities to use and become familiar with the scheme, particularly as many schools are adopting the scheme in part or entirety.

Because of the revision of the National Curriculum Order we will also need to consider how our course will complement the new requirements of the Order. For example one area which we are already looking to develop greatly is the use of Information Technology within design and technology. The Faculty is updating and increasing its computer provision and we are also in the process of obtaining more resources for computer control. We also plan to give more dedicated time to the area of designing, which research shows is poorly taught in schools.

Even colleagues from other subject areas came and had a good look at the final products

In 1998 the Department for Education and Employment (DfEE) published Circular 4/98 entitled 'High Status, High Standards'. This details the requirements for initial teacher training courses, and discussions by representatives from higher education institutions have already started to determine how the requirements of this circular can be met. This has implications for this course in that we need to ensure that our students can meet a required standard. We are also using the guidance outlined by DATA (1996a) to support us with this task.

Taking all of these factors into consideration we shall review, and where appropriate make changes to, the course in readiness for the next intake in September 1999.

Teaching practice

During May 1999, the first year students started their main 5 week block teaching practice. Many of the students were able to have opportunities to plan and teach design and technology in their schools. This is where all the theory, skills, knowledge, understanding and information gained from the course will be put into practice!

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Do conventional INSET methods work in a developing country? The ORT-STEP Western Cape approach

ORT-STEP Western Cape, Cape Town, South Africa. E-mail whoopi@global.co.za

Sally Vassilaros & Lionell Horn

Introduction

The ORT-STEP (The Organization for Educational Resources and Training – Science and Technology Education Project) Institute was established in 1993 under the auspices of world ORT. ORT-STEP's primary functions were to create an awareness of technology and train teachers in teachers in technology education at both primary and secondary level.

This paper outlines developments regarding The ORT-STEP approach to training teachers in Technology Education.

Overview of current INSET courses available for Technology Education

In South Africa, the Education Department aims to introduce Technology Education into all schools by the year 2005. A national task team has been established to drive the awareness and implementation of this new learning area. In each of the nine provinces, the training of teachers for Technology Education has been approached differently. Much of the training has been workshop-based, but in Gauteng and the Eastern Cape the ORT-STEP Institute has trained teachers from forty pilot schools. However, due to budget constraints a number of the provinces have shelved Technology Education until a later date. Thus only a limited number of teachers have been trained to deliver Technology Education competently and confidently.

ORT-STEP began training teachers in Technology Education in 1993. The initial course offered was a two-year, part-time course for secondary school teachers, which involved 300 contact hours. About a year later, a similar course was offered for primary school teachers. These courses meant that teachers had to commit to two years of part-time study and (more often than not) that they had to pay for the courses themselves. Moreover, all courses were only conducted in English and teachers had to travel to one of the six ORT-STEP branches.

This approach resulted in the exclusion of the majority of teachers, particularly those teaching in historically disadvantaged schools since they found the course fee and travelling costs to be prohibitive. Many of these teachers had to travel to the lecture venue by public transport, and since lectures were held after school hours they had to travel home after dark. This arrangement was not only tiring but also unsafe.

Changing the approach of teacher training at the branches

The ORT-STEP course was redefined into a modular approach. Nine modules (the foundation course; materials and structures; energy, electricity and electronics; food technology; textile technology; information technology; man, society and the environment and mechanism) were developed in place of the two-year part-time course. Teachers can elect to do modules according to their needs and resources (time and money). The modules are offered after school hours and during the school holidays.

Since introducing the modular approach in 1998, 62 students have completed all nine modules or a number of these modules (74.7%) compared with only 21 students (25.3%) who had completed the two-year part-time course since 1994 (Table 1).

The advantages of training teachers in an adequately equipped, stimulating environment are numerous. Teachers are able to work with a wide variety of tools, equipment and research resources (books, videos, CD-ROM and access to the Internet). Displays of work and up-dated information on publications, posters and seminars expose teachers to new developments. Resources such as photocopiers and computers allow teachers to share information.

The move to project-based teacher training

There was a growing need to reach a greater number of teachers in more distant areas in South Africa. The introduction of project-based teacher training would accelerate the implementation of Technology Education in schools. However, a number of problems such as geographic area, distance, language of instruction and appropriate courseware needed to be addressed. While the course needed to be adjusted to meet the needs of the group, we had to ensure that the appropriate knowledge, skills and attitudes of Technology Education were retained.

Project-based partnerships, between the ORT-STEP Institute and commerce and industry have been developed. This has resulted in a more cost-effective approach to teacher training and created awareness among businesses. The Institute is able to reach

Coarse	Year	Students Graduated	Percentage
2yr part-time	1994 – 1997	16	19.3
2yr part-time	1998 – 1999	5	6.0
All 9 modules	1998 – 1999	49	59.0
2 – 6 modules	1999	13	15.7
Total		**83**	**100.0**

Table I Number of students trained by ORT-STEP (Western Cape) teachers in areas that are a fair distance from the branches. Through the funding received from business, we were able to subsidize the fees of students from previously disadvantaged groups.

The schools participating in these projects sign an agreement to ensure maximum usage of the training and facilities provided by ORT-STEP. Pupils and teachers from these schools are encouraged to share their facilities with other local schools.

There are a number of projects being run in Gauteng, the Eastern Cape and the Western Cape. Our projects are situated in areas that were historically disadvantaged under the previous government.

Current projects in the Western Cape

The Western Cape is the second largest province in South Africa – England would fit into this province approximately four times. There are about 2000 schools in this area, the majority of which are in the Cape Peninsula.

The Western Cape branch of ORT-STEP has established projects in Kraaifontein, Worcester and Khayelitsha (Figure 1).

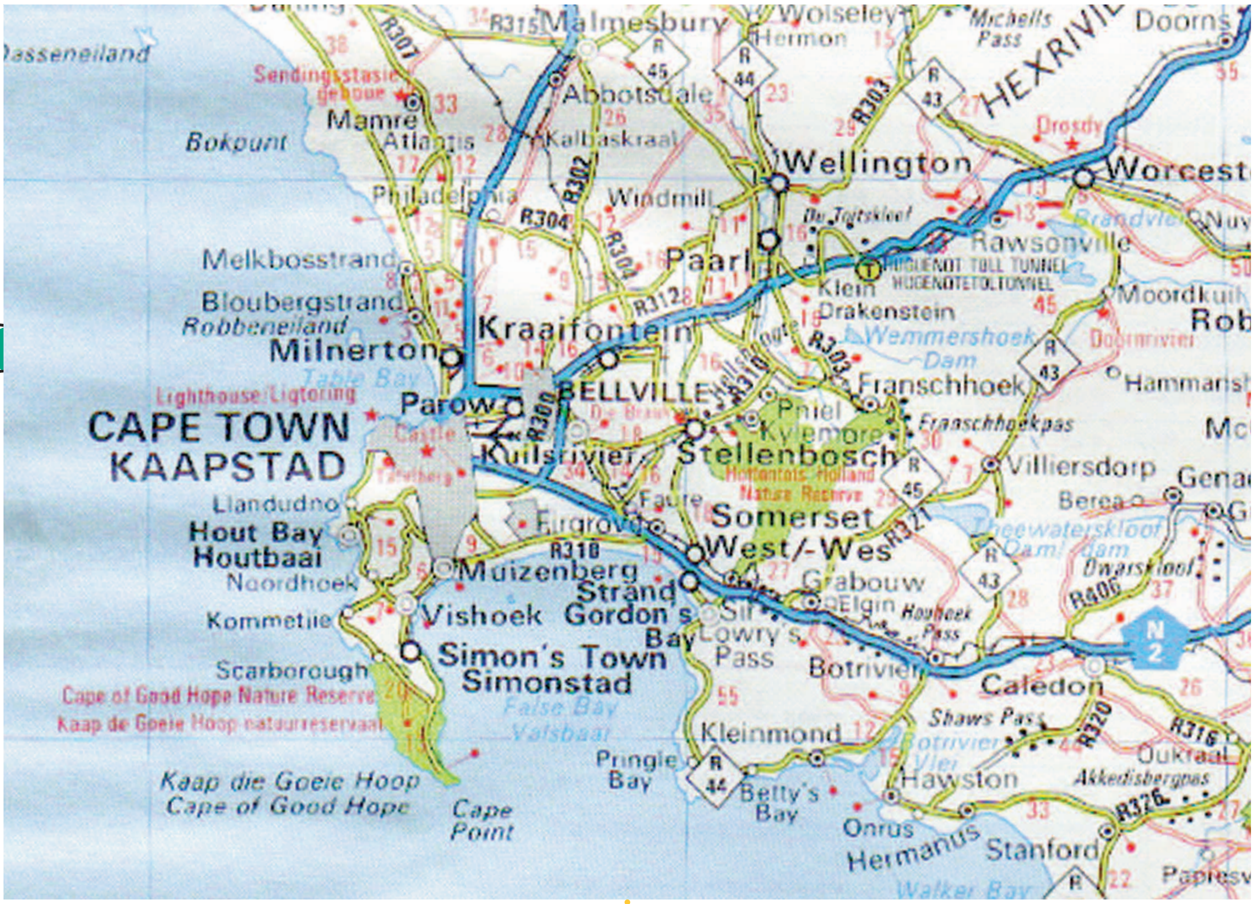
Each of the projects is sponsored by a large business in South Africa. The courses are structured according to the modular system and aim to reach and teach as many teachers in the areas as possible. Table 2 indicates similarities and differences between the projects.

Areas were chosen according to teacher interest and because many could not attend lectures at the branch in Cape Town. This project-based teacher training is proving more cost and time effective than conventional INSET approaches since it delivers the lectures close to the schools in a particular area. Another distinct advantage of setting up the projects at schools in these areas, is that teachers could learn to deliver Technology Education within the reality of their own classroom situation.

One of the aspects of the project-based teacher training is to encourage teachers to form committees, which meet regularly to plan units of work and exchange ideas. This aspect is vitally important as Technology Education is a relatively new learning area at this time and teacher interaction provides much needed support.

In equipping schools with Technology centers, teachers are able to put into practice the knowledge, skills and attitudes they learn throughout the course.

Figure 1 Map showing project areas in Kraaifontein, Worcester and Khayelitsha



	Kraaifontein	Worcester	Khayelitsha
Sponsors	ABSA	Coca-Cola	ENGEN BP (British Petroleum) Barbara Malk Rotary – Cape Town The Poldershank Foundation
Language of instruction	Afrikaans and English	Afrikaans and English	Xhosa and English
Delivery time frame	18 months	15 months	24 months
Modules delivered	Foundation Course; Materials and Structures; Energy; Electricity and Electronics; Food Technology; Textile Technology; Information Technology; Man, Society and the Environment; Mechanisms		
Technology Centre in schools	8	1	1
Project schools	8	10	5
Pupil profile	Age 6 – 13 yrs Multi-cultural Afrikaans, English and Xhosa first language		Age 6 – 18 yrs Single culture Xhosa first language
Pupils / class	38 – 75	39 – 73	45 – 68
Teachers being trained	17	20	20
Area profile	Residential area Small businesses area B Borders on farming region Small shopping area 30 – 40% unemployed Poor to average literacy	Residential area Light industrial area Small-holdings Grape & fruit farming Shopping complex 35 – 45% unemployed Average level of literacy	Largely squatter camp with some formal housing One shopping area Numerous Spaza shops Few adults employed Poor literacy level (Y5)
Electricity and water	Formal housing has electricity and water. Squatter camps may have an electricity meter + a single tap within 200m of each home		

Table 2 Comparison of the three projects set up by ORT-STEP (Western Cape)

Conclusion

There has been a shift away from formal two-year part-time courses at ORT-STEP because of financial constraints, the need to cover large geographic areas and the heterogeneity of the teacher population particularly with regard to language and culture. The project-based approach, taken to areas which have been chosen according to teacher interest and partially sponsored by big businesses, are proving to be very cost and time efficient without compromising the knowledge, skills and attitudes of Technology Education. In developing countries such as South Africa this option of teaching training is thus probably more appropriate than conventional INSET approaches.

Building bridges. Developing links between Key Stages 2 and 3 using Design and Technology

Danesmore Park Primary School, Wednesfield, Wolverhampton, West Midlands, England

Telephone +44 1902 558551

Sue Vaughan – Design and Technology Coordinator

Introduction

Danesmore Park Primary School is situated in Wednesfield, a district in the north of Wolverhampton. There are approximately 280 children on roll, with a further 40 children who attend the nursery part time. The school has a designated base for pupils with moderate learning difficulties (MLD). At present 25 pupils have Statements of Special Educational Needs for MLD. There are also approximately 50 pupils who are on the Special Needs Audit and require extra support. The school policy is that the Special Needs children are fully integrated into mainstream classes with additional support to meet their needs. Classes in Key Stage 2 are vertically grouped, with Years 3 and 4 together and 5 and 6 together.

Design and technology within the school was our weakest curriculum area. This was due to a combination of a lack of confidence, expertise and understanding among the staff. Over the last three years we have worked hard to improve the design and technology provision for our children. Following professional development, which was given to the Coordinator, a whole school scheme of work has been implemented, which incorporates many of the units of work from the 'DATA Guidance Materials for Key Stages 1 and 2'. These units have helped to give structured guidance for staff. As staff have worked with these units now for three years, they are becoming more confident in making modifications and developments and enabling more creative responses to come from the children. We still feel that we have got a long way to go, but are getting there gradually. Resources for the teaching of design and technology have also been extended.

Primary / Secondary Liaison

Over the years, we have developed particularly good links with our local secondary school – Coppice High School. The majority of our children transfer to Coppice at the end of Key Stage 2. The transfer from primary to secondary school is a time of terrific change for the children, and can be extremely traumatic for them. Let's face it, it is a time which most of us as adults can remember vividly from our childhood! We believe that good liaison is crucial to enable this transition to be as smooth as possible.

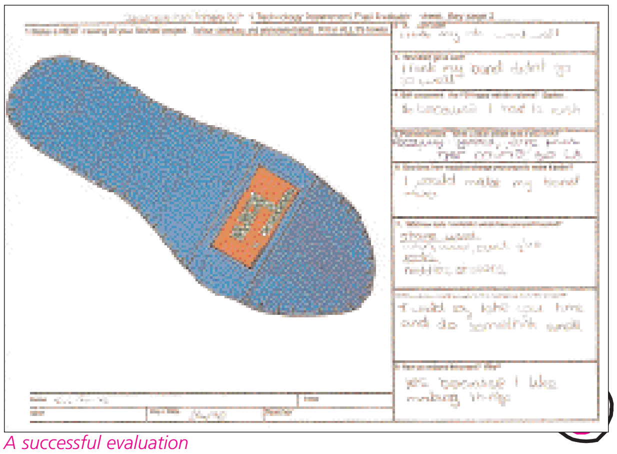
To facilitate this liaison, we have developed various strategies to enable the children to transfer smoothly. We liaise with staff from Coppice, discussing individual children and their needs. Staff from Coppice give lessons within our school, such as French, to enable our children to become familiar with their staff and to see different subjects, which they will eventually study. Year 5 and 6

A brief evaluation

children visit Coppice regularly for swimming lessons, which also helps them to get used to the actual buildings, staff and gives them an insight into how children have to move around the secondary buildings. In the summer term, we are offered 'Link Lessons' at Coppice to enable the children to work in specialised areas such as drama, art, I.T. and so on.

Primary / Secondary Liaison in Design and Technology

Following the success of these 'Link Lessons', we were asked to make suggestions for other subjects which could be offered. I particularly requested some lessons in food technology, as we were finding this a particularly difficult aspect of design and technology to implement. We did not have adequate resources, particularly if any heating of food was to be involved. I liaised with the teacher in charge of food technology and we managed to arrange for our Years 5 and 6 children to have two afternoons each at Coppice, making fruit salad and fairy cakes. This was particularly successful and highly motivational as it enabled the children to use resources which were not available in our school



A successful evaluation

Thorough mixing required

and enabled them to see secondary organisation in a practical setting, thus helping them to reduce their 'fears of the unknown'. They also really enjoyed these lessons! We repeated this last year, making 'Chocolate Krispie Cakes', enabling the microwave ovens to be used. This link has enabled us to give the children opportunities, which we find difficult to give them at our school, and has enabled our staff to further forge links with a wider variety of staff at Coppice. We hope to be able to maintain these lessons.

Laura says "Help!"

This year, I was contacted by Martin Corcoran, the Design and Technology Coordinator from Coppice, with a view to creating a display at the Civic Centre, in Wolverhampton. This display is to celebrate 'Design and Technology on Ashmore Park' and is to take place at the beginning of June. Three organisations are to be involved: 'Coppy Quacks', (a pre-school group), Danesmore Park Primary School and Coppice High School. The intention is to show design and technology and how the subject is being developed right from a very early age, through Key Stages 1, 2, 3, 4 and GCSE etc, showing elements such as continuity and progression.

The creation of this display has meant that the Design and Technology Coordinator has been to our school to discuss what is to be included etc. He has seen examples of the work carried out in our school from the age of 3 to 11. I am to visit his department at Coppice to see the work carried out by the older students, and to see what resources are available there. Already help has been offered with a view to providing some square cut sections of wood for our framework projects. The liaison involved in this project is giving myself and Martin an awareness of the design and technology work which is going on, in my case, after the children leave our school, and in his case before they come to him.

This means that I can relate our work to what I know will follow and that Martin has an understanding of what our children have already achieved. We hope that if this project is successful, then other local schools may become involved in it in the future, thus widening the awareness of design and technology in local primary schools. The difficulty of course, is that our school is only one of many primary schools, which feed to Coppice High School. But still, this is a positive start!

Raising the status of design and technology through a family learning focus

Patricia Ann Webster, Design and Technology Consultant, 91a, Furniss Avenue, Sheffield, England, S17 3QN
Telephone / Facsimile +44 114 2361648. E-mail p.websocc@gemsoft.co.uk

Introduction

What would make you leave the comfort of your armchair on a wintry evening, or entice you to cope with a baby on your knee, a toddler sticking things together, your eight-year-old sawing wood and a teenager arriving asking 'what's wrong with this circuit?'

The answer – Design and Technology!

The benefits of 'family learning' as a way of raising standards and improving home/school communications are well known. The project I am leading uses Design and Technology as a highly motivating focus for families 'finding out together' about how things are made and how they work.

In addition to the benefits normally associated with this type of out of school activity, it also produces a significant improvement in the standards of Design and Technology achieved and raises the profile of the subject.

Over the last year I have observed

- An improvement in the status of the subject, particularly in the eyes of parents and school governors, as they realise the thinking processes involved, the amount of concentration needed and the level of skills required, to complete a task, anticipate the next step and produce a good quality finish
- Children reading to understand as they follow instruction sheets, construct programming sentences and enjoy stories that they can re-tell using puppets and other props
- A rapid improvement in the level of skills acquired by all the members of the after school technology club, including pre-school and special needs children
- Clarification and reinforcement of areas of knowledge and understanding as children take on the role of teacher, as they help others with their designing and making activities
- High quality products being produced as a result of the resources available, the additional support provided by parents, carers, teachers, students and other professionals involved in the workshops and the motivation to succeed when all these people are interested in the outcome
- Practical activities being seen as a worthwhile way of spending time together helping to demonstrate that adults value making as a purposeful occupation
- Communication, mathematical and problem solving skills being extended as families become involved in planning, carrying out and evaluating projects
- Parents/carers growing pride and confidence, as they too try new projects, that they did not cover at school or re-visit areas they have forgot or only partly understood
- Learning being continued at home, as projects are finished off or additional features added
- Sharing of work undertaken at home, raising the self-esteem of all those involved
- Improvements in family relationships as individuals take on different roles and find themselves in a learning situation
- The benefits of a partnership scheme as industry, the university and community college, schools, parents and educational charities work together to raise standards and increase community involvement
- A great sense of enjoyment – from grandparents to head teachers, from toddlers to teenagers – they all agree D&T is great!

What does the project involve and how it is funded?

The three-year project is based in Nottingham, with five primary schools currently taking part – Brinkhill, Brooksby, Glapton, Milford and Whitegate- all located on the Clifton estate. At present we are averaging 30 families per session, which represents between 50/120 people per workshop.

When 'The Boots Company' decided to support a 'family learning' initiative, as part of their community programme, I was appointed as project leader.

A set of eight aims were agreed, with support from Education Extra and in consultation with the other partners in the project, including 'The Boots Company', Fairham Community College, Nottingham Trent University, the five primary and two 'feeder' secondary schools and the L.E.A.

Aims of the project

- To maximise the benefits of the family unit as a base for learning
- To support parents as children s first and natural teachers and to encourage parental involvement in education
- To encourage the partnership between parents and teachers, working to enhance the experience of the children
- To facilitate the three-way partnership between children, their parents and their teachers
- To support the prescribed syllabuses in school that encourage young people to work and find fulfilment in learning
- To foster the participation of business and industry in educating young people and their parents
- To create opportunities for parents to work together with their children at school and at home
- To develop a sustainable model of family learning practice.

The development, content and format of the project workshops are my responsibility.

In the early nineties I established a Design and Technology Centre in Sheffield, moving on later to become an adviser and inspector for the subject. I knew the potential of this area of the curriculum to motivate children and extend their basic skills.

'The Boots Family Learning Project' provided an opportunity to introduce parents and grandparents to a 'new' subject, that may not have covered when they were at school, and to raise the profile of 'design and make' activities within the community. This strategy would also help to raise the standards of D&T within the project schools.

I was able to draw on my previous experience of working with parents to establish the project. This included work in school, at the Design and Technology Centre and through developing and managing an event called 'The Families Finding Out Together' based in one of our local industrial museums. This includes inter-active educational activities that help families to learn about the processes involved in the production of steel.

The Feathers Club

We decided to call the project the 'Feathers' club, which stands for: Family Evening Activities That Help Everyone to Relax Socially

The schools felt that the 'Feathers' club would give a more 'user friendly' image and help families to feel less threatened by the idea of technology based activities.

Each school has three workshops per term. A 'Feathers' workshop lasts ninety minutes and takes place straight after the end of the school day. Refreshments are served as families arrive, to allow a social time for parents/carers and an opportunity for the children to 'switch off' from school and 'tune in' to the activities.

Receiving a 'special Award' certificate for her puppet theatre

After the introduction, when certain learning and safety points are made, families become involved in an activity they choose from the range provided. Stimulus models and other visual aids are used to make the workshop come to 'life'.

Students from Nottingham Trent University, the head and project teachers from the school and myself are all available to help the families with the making activities and to give encouragement.

When the families have successfully completed their 'design and make' project the children talk about their model with one of the students. They are then awarded a recognition certificate, which they keep in their 'Feathers' folder, along with any design ideas, 2D work, information booklets, drawings etc.

The progress of the project is reviewed three times per year, giving an opportunity for continual development work, together with the solving of any logistical problems.

Holiday activities are being used to extend the project and show Design and Technology in a wider context. Steel production and the use of waterpower being the two areas covered so far.

Funding is provided by 'The Boots Company'. They are one of the largest employers in the area and undertake many community initiatives.

Education Extra support out of school activities and are involved in an evaluation role, as well as disseminating the outcomes of the project through conferences and newsletters.

Getting the project started

The workshops needed to be enjoyable and in some cases 'undo' the negative experiences that parents/carers may have encountered when they were at school.

My initial priority was to get families to come along and have a positive time working together.

Some of the strategies I used to get the families involved, included:

- Giving talks, running staff meetings and producing posters, to share the aims of the project and to ensure an enthusiastic response when models started to appear
- Working in classrooms to prove my credentials to staff and pupils and to stimulate interest in the new 'Feathers' club, when the children took their models home. I made sure that the quality of the materials used and the finish achieved was of the highest standard
- Developing a corporate image- the 'Feathers' logo was used on the children s folders and on the badge they made out of Shrinkles (a plastic sheet material that shrinks when heated) as part of the first workshop

The children used their developing skills with electrics to make a pressure pad for their 'buzz bag'

- Using familiar products such as LEGO and K Nex to encourage a wide interest group. Using pull back motors, that proved to be fairly indestructible, we built and raced K Nex dragsters! This was a great success and resulted in many families buying construction equipment for their children to work with at home
- Using the learning experience of one workshop to reinforce the next workshop. This helps to build confidence and ensure progression
- Producing a termly booklet that suggests simple activities that families can try at home, or when out shopping. So far we have covered wheels and materials
- Making sure the workshops have 'user friendly' titles and activities. We have had 'Festive Feathers' (focus – stored energy) and 'Feathers' in a spin' (covering gears and pulleys). These familiar themes enable quite complex mechanisms, circuits and skills to be covered in exciting and relevant contexts – for example – the use of an eccentric wheel, causing the sinking of a model Titanic, or a buzzer announcing the arrival of a favourite story!
- Encouraging children to bring their models back to school to show in class or at assembly time. This is really beginning to work well. A head teacher comments 'One family – Mum, Dad, 2 brothers (year 7 and year 2). Very enthusiastic they have always finished work or added to it after the sessions. They then took up the challenge to make things at home – D&T skills for that family developed at pace – planning, building, revising and improving. They have now produced a hovercraft, which they have donated to school. A significant home / school / pupil / parent cycle has been established.'
- Talking to the parents and listening to their views. I hear comments such as 'I never realised my child/children could produce such good quality work . It's such hard work, I never knew that there was so much involved in making a simple model!

Other parents confess that they have never tried or had the opportunity to do the kind of work we do in the workshops – they say that they now have confidence to try projects with their children.

One Grandma told me – 'it's wonderful, at last I've got them away from the television!'

Other comments include

- 'It's even good for the community. They know something's happening here. You walk out of school carrying what you've made and people stop and ask you questions about it. I gave my puppet to a lady in a wheelchair and it made here day.'
- 'Parents can actually see what their children's capabilities are. When you're at work you simply come home and read them a story and leave it at that – you don't do things of this calibre with them.'
- 'You're probably got everything here at home, but you wouldn't dream of putting them together the way you do.'
- 'I made a Christmas tree with flashing lights – I'd never in my life done anything like that before.'
- 'Children/adults learning together – positive messages about life long learning'
- 'I enjoy it – it's fun – its not often you get a chance to talk to a governor – normally you don't even know who they are.'
- 'We are able to use the National Curriculum creatively and extend it around our own children's interests, for example all the work they did with circuits could never have been done in a classroom.'
- 'If I go home I'll just be cooking and everybody else will be watching the telly, too busy to talk to each other. This is my daughter's time.'
- 'The quality of work produced is amazingly good'.

Consolidating the success of the project

We are now into the third term of workshops and everyone involved agrees that the atmosphere, the quality of the work produced and the numbers attending are still really good, so what are the main factors making it successful?

- The speed of leaning and the quality of the outcomes, partly produced by being able to repeat, in a relatively short time, the same skills and areas of knowledge and understanding then moving on to ensure consolidation and progression
- A good range of differentiated activities these ensure that everyone, from pre-school children to pensioners, gain a sense of achievement within a relatively short time

- Special Award certificates to give children pride in their work and to act as a record of their making activity. These include a comment from the person they have been working with
- Establishing good practice in the storage and presentation of materials. This has been essential – many parents and teachers comment on the bliss of working with such high quality materials and in turn these results in the production of high quality products
- Giving people time and space to develop their skills – at their own pace and in their own way, for example learning in parallel or by questioning
- The social as well as the technological benefits – with families helping families – young helping old. Some families, who are having difficulties at home, find the therapeutic nature of the activities and the social time with other adults, helps them to work out their problems
- Taking learning beyond the school environment and into the wider community. This was one of the original aims of the project. It has been achieved by organising holiday activities
- Involving trained personnel so the quality of the work produced is maintained.

Mum and daughter finding out together – working in 'parallel'

The students, project teachers and myself are all there to demonstrate techniques, discuss the possibilities of different materials and extend the children's problem solving and language skills.

The team acts as a positive role model, encouraging pupil's interest in Science and Technology, as well as proving that learning and further education are valuable – and fun!

We are also able to support children who are not working directly with their parent/carer. This is very important, with older children having their knowledge extended, or a 'harassed' parent being given additional support with a younger child.

The students pass on their knowledge and enthusiasm to the families during the workshop and in return they receive a certificate and an outline of the project to include in their C.V.

Many of the students now want to be D & T coordinators, and all agree that they are bursting with ideas for their next teaching practice.

What Next?

- To build on the work of the partnership. A Story Sacks workshop, funded by the project, has already resulted in one school receiving additional funding to develop their own story sacks and train parents to support their children s early literacy skills. The aim is to support this initiative in the other project schools
- We also hope to recruit families from the FEATHERS club to run workshops for the employees of The Boots Company as part of their annual open day
- Extend the project to include other schools and areas of the country. This may be achieved by working with other industries, by funding through the New Opportunities Fund or additional projects supported by 'The Boots Company'
- Produce activity packs and resource details – to enable other groups to work on similar projects – further raising the standards and status of Design and Technology
- Introduce an accredited training course for parents and other interested adults. The course – Developing Children's Technology Skills – is being considered by the Open College Network recognition panel and should be ready for September 1999.

Future workshop leaders and project support workers will be recruited from course members, but it is hoped that grandparents, play group leaders, after school club personnel and any individual or group of people interested in extending their own knowledge, will also take part.

The units will cover the skills, knowledge, materials and types of activities involved in a 'design and make' project, together with the appropriate questions needed to extend a child's Design and Technology capability. Créche facilities will be provided – so – someone on the course will not have to cope with a baby on their knee!

From stick figure to design proposal: Teaching novice designers to 'think on paper'

Queen's University, Faculty of Education, Kingston, Ontario, Canada, K7L 3N6. E-mail Welchm@educ.queensu.ca

Malcolm Welch and Hee Sook Lim

Introduction

This paper begins with a review of the literature describing the role of sketching in designing and making. Next, the method used to teach sketching to Year 7 students and to collect and analyze data is outlined. This is followed by discussion of the impact of this instruction on the students' design proposals. The implications of these findings for the teaching of sketching complete the paper.

Setting the context

Activity with crayons and paints is pleasurable to most young children. They quickly develop the ability to sketch simple stick figures and outlines of shapes. Their sketches are typically spontaneous, uninhibited expressions of both their inner world and the material environment that surrounds them. Once they enter formal schooling drawing experiences are an integral part of most curricula. Why then is it so difficult to persuade design and technology students to sketch ideas before they start to make things? Is it because they lack the requisite skills?

This paper reports the results of a study designed to investigate the effect of instruction in sketching on the ability of novice designers to produce a solution to a design-and-make task. Previous research (Welch, 1996, 1998) showed that novice designers do not use sketching as a way to explore and communicate design proposals, but move immediately to three-dimensional modelling. Neither do they generate multiple solutions in order to choose and further develop the one with the most promise. Furthermore, novice designers lack the requisite modelling skills to explore their ideas and to communicate them to others. These results have important implications for the teaching and learning of modelling as a central activity in designing and making.

The follow-up study described here addressed the questions: How can two-dimensional modelling be taught to Year 7 students so they are better able to express their ideas and organize their thoughts? Is there a relationship between the ability of a student to sketch and the quality of design proposals produced? What specific skills, knowledge and materials are required for both teaching and learning sketching?

Thinking on Paper

Sketching is a form of thinking and the fundamental language of design, characteristics which make it central to students' success in design and technology. Tipping (1983) has suggested that fluent sketching ability may be "the single most important factor in developing any general design ability" (p. 45). Archer (1979) refers to drawing "as a fundamental component of the wider language of modelling, which in turn is the essential language of design" (p. 133).

According to Olszweski (1981) the idea that sketching is a form of thinking first appeared when the old Italian name pensieri, meaning "thoughts", was given to sketches in the art and design world of the Renaissance. Brett (1986) views sketching as "an activity fundamental to human action… .Along with counting and speaking (it is) a primary form of cognition" (p. 59). Temple (1994) has described sketches as "thoughts in action" (p. 323) and Kafai (1995) describes sketches as "objects-to-think-with" (p. 10).

Sketching is essential for communicating ideas, both with "self" and others (Lowe, 1993; Robbins, 1997; Temple, 1994). As Robbins (1997) points out sketching has both a monologic and dialogic function: "Earliest sketches, with their fits and starts, the changes they confront and record, and the questions they raise represent both an interior dialogue that has taken place within the designer and, often, an exterior dialogue with others concerned with the drawings" (p. 35).

Sketching is a complex task (Schenk, 1997) that permeates designing from start to finish and is used for a variety of purposes. First, in the early stages of designing, sketching may help to explicate needs, define and clarify the task. Sketching is a crucial part of the process of understanding a design problem.

Second, sketching allows and encourages the designer to 'play' with ideas, an essential stage to creative idea development (Garner, 1994). Sketching is a powerful tool for formalizing, exploring and testing these playful musings. Unlike the time-consuming and more costly experimenting with three-dimensional materials and models, designing with pencil and paper provides greater room for experimentation.

Third, sketching facilitates the evaluation of a design proposal and the identification and restating of problems. Sketching provides a means of testing concepts (Temple, 1994), which in turn will encourage the further generation of ideas (Garner, 1994). Evaluation permits progress "from an innovative mental image to a vehicle for analysis and criticism" (Temple, 1994, p. 24).

Fourth, because sketching is a language it facilitates rapid communication both with the "self" and others. Sketches serve to direct, order, clarify and record ideas that come out of this conversation. Sketches record the ongoing conversation with self as thought is externalized and developed into design solutions. Such conversations, according to Garner (1994) "may involve asking the right questions, constructing the right structures and providing conjecture" (p. 68). Additionally, the externalization of visual thinking as sketches allows people other than the designer to participate in the development of a proposal.

Unfortunately students do not view sketches as either "objects-to-think-with" or as a language to facilitate communication and evaluation of ideas. Even when forced to sketch they will cast aside one sketch to make room for beginning another. The gradual accumulation and refinement of ideas through sketching is not perceived as an integral part of designing and making. So how can students be taught the skills and attitudes to "think on paper"? The next section of this paper describes an intervention study in which the effects of teaching sketching on the strategies used and the design proposals produced by novice designers was investigated.

Method

Two Year 7 classes participated in the study. All students in Class A were given instruction in freehand isometric sketching. This instruction, given by the regular classroom teacher after in-service training, was part of a 20-hour unit of work focusing on structures. Students in Class B did not complete the unit, received no instruction in sketching, hence served as a control group. Following completion of the structures unit eight students from each class were selected and divided into single-sex dyads. The eight dyads were each given the following context and design brief:

The Situation

Your best friend has had an accident. While not seriously hurt he/she is confined to bed in the hospital for two weeks. Not able to move very much, and able to use only a bed tray as a play surface, your friend has told you they are becoming bored and wish they had a new toy or game to play with. You have decided that when you visit next time you will take a toy or game you have designed and made. You now have to make some decisions.

The Design brief

Design and make a toy or game that will amuse and intrigue a bed-ridden hospital patient aged approximately 12 years and that can be played with on a bed tray.

After reading the context and brief students were instructed to complete a worksheet (Figure 1) containing a set of contextualizing questions before starting to design and make.

Students were given two hours in which to complete the task. Their designing and making was video and audiotaped. The natural talk between the subjects was transcribed verbatim and the transcripts were segmented into speech bursts. A description of the subjects' actions was added to the right of each segment. The time at which a change in the subjects' actions occurred was added to the left of each segment, thus allowing calculation of the duration of each period of action.

A coding scheme (see Welch, 1996) was used to code actions of the subjects. The natural talk while designing and making informed the coding. Those actions coded as designing were analyzed using descriptive statistics. This analysis provided data for "mapping", using an XY scattergraph, the design strategy of each dyad. These maps provided a visual representation of the design process used by each dyad, which in turn permitted a comparison both between dyads and between the two groups of dyads. (For a more complete description of this method see Welch, 1996, 1998.) Analysis provided insights into the effects of instruction on the proposals produced by students, as well as feedback on the efficacy of a set of instructional strategies for teaching freehand sketching.

Designing a toy or game for a friend in hospital

The eight questions below will help you begin thinking about designing a toy or game for a bedridden friend. Try to answer all the questions before you begin developing a solution.

1.1	What type of toys do you and your friends play with?
2.2	What type of games do you and your friends play?
3.3	List some toys or games that require hand and eye coordination
4.4	List some toys and games that can be played alone
5.5	List some toys and games that can be played alone
6.6	List some toys and games that you play with one or more friends
7.7	List some educational toys and games
8.8	What safety issues are important?
9.9	How often will the toy or game be used? For how long?

Figure 1 The contextualizing questions

Results

Figure 2 shows the strategy use by Dyad 8 and is representative of the four dyads who received instruction in sketching. Figure 3 shows the strategy used by Dyad 1 and is representative of the four dyads from the control group. Both maps show clearly the small amount of time devoted to sketching.

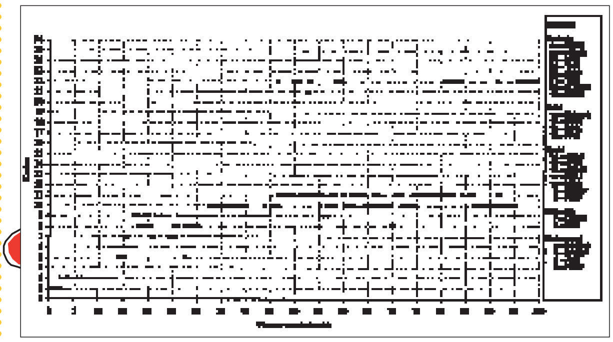


Figure 2 Stategy used by Dyad 8

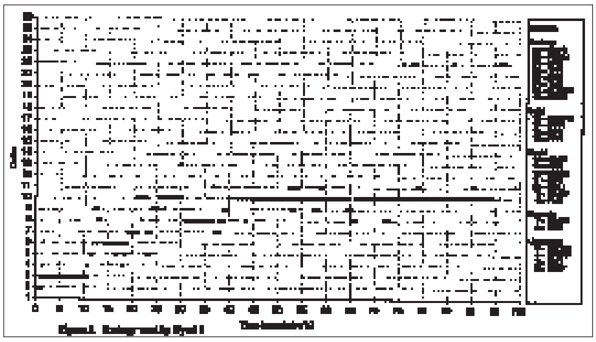


Figure 3 Stategy used by Dyad 1

However, six of the eight dyads appeared to recognize that sketching precedes modelling and making with three-dimensional materials. For example, S16 picks up a piece of paper and a pencil and says to his partner "Why don't we make a rough sketch of what we're going to do?" His partner responds "Yeah, paper. That's like our… going to be like first and then we'll do it" (lines 446-450).

Of the six dyads who made some attempt at sketching a proposal three were in the control group. Of the four dyads (1 in Class A and 3 in Class B) who made a board game two (both in Class B) sketched very detailed plan views. However, these were not drawn prior to making the game, but rather were developed as making was in progress, providing a written record of making as it occurred rather than a plan for future action. The other two dyads who made a board game made no attempt at sketching. Dyad 3 (Class A), who made a toy that involved dropping a marble down a columnar maze, carefully divided a sheet of paper into four equal parts. In the top left section the student sketched a side view of the maze. In the top right section he sketched a top view and in the bottom left section a "bottom" view. Dyad 2 (Class A) and Dyad 4 (Class B) each sketched a side view of a marble maze, but once completed (in just a few seconds) never again referred to the drawing. Dyad 8 (Class A) made the most accurate sketch of what they proposed, but even so spent very little time on this.

The maps also show the dominance of three-dimensional modelling, a result consistent with that from two previous studies by the author (Welch, 1996, 1998). The maps show how, once the students had completed the contextualizing questions, they moved quickly to modelling using three-dimensional materials. The students were almost constantly manipulating materials as they explored elements of a proposal. They did not, on any occasion, return to drawing as a way to explore modifications to their original solution. They generated new ideas by manipulating three-dimensional materials, not by sketching.

The contextualizing questions

The contextualizing questions appeared to play a significant part in the development of a solution for all eight dyads. While answering the questions the students interspersed their conversation with discussion of the performance criteria contained in the context: the person is confined to hospital, cannot get out of bed and the only flat surface available is a bed tray. For example, when S15 and S16 are responding to the question "List some toys or games that require hand and eye coordination" the following conversation occurs:

S16: Like hockey 179
S15: You can't play that in bed 180

When S1 and S2 are reviewing their answers to the questions S1 notes that S2 has written the word "never" on the answer sheet. This prompts the following exchange:

S1: Never. What's that? 435
S2: Never ending games. 437
S1: Never ending games? Why would you 450
have never ending games? 451
S2: Because you don't know how long he's 453
going to be in there, and you don't want 454
him to run out of ideas. 455

The contextualizing questions also stimulated discussion of solutions and appeared to provide a supportive way for subjects to develop their ideas. Simultaneously discussing and manipulating materials was also a preferred strategy of subjects. The data suggests that this is an important strategy for students as they attempt to clarify, explore and communicate their ideas. In other words, it appears that it is not appropriate to require students to only think about or sketch solutions.

Discussion

Analysis of the way in which subjects in this study generated possible solutions has made evident four characteristic behaviours: (a) their previous knowledge is drawn on in order to generate solutions; (b) sketching is not a method by which subjects explore solutions; (c) discussion between subjects plays a major role in the clarification of ideas; and (d) subjects rely heavily on simultaneously discussing a solution while manipulating materials.

According to Hayes (1989) "it is a very rare event for a person to solve a problem without making some use of their own knowledge of… the world" (p. 51). There is evidence from this study to support the findings of Kimbell, Stables, and Green (1995) that when subjects are generating solutions "previous knowledge is drawn on and developed in new contexts" (p. 34). For example, while responding to the contextualizing question "List some toys and games that require hand and eye coordination", the students in Dyad 8 had discussed a "ball and cup" toy. The conversation went as follows

S16: …there's this game 195
where you hit it off the thing and 196
you try to get it into a cup. It's like, 197
I forget the name of it, but its like 198
you have this thing, its like a handle 199

and there's a ball… 200
yeah, you try to get it in… 201
S15: Don't know what its called. 202
S16: Just put ball and cup. 203

Most design process models contained in the technology education literature include a step during which the student must sketch several design proposals from which they can select the most promising. Figures 2 and 3 illustrate how little time subjects in this study devoted to generating a single proposal by sketching prior to three-dimensional modelling a solution. Several dyads did make perfunctory attempts at sketching a solution, but these were quickly discarded in favour of exploring possible solutions by manipulating materials. Equally evident from the data is that subjects did not generate a range of possible solutions from which they could choose the one with the most potential. In all cases subjects proposed and developed one solution. A small number of empirical studies have provided evidence that this strategy is also true for expert designers (Darke 1979; Eastman 1970).

The data shows that students need little encouragement to talk about their ideas. It is important to permit this, for as the Department for Education in the UK suggests "by talking about the quality of their own work and the work of others children learn to evaluate" (Department for Education, n.d., no page). This approach is supported by Schôn (1987) who wrote "drawing and talking are parallel ways of designing and together make up… the language of designing" (p. 45).

Conclusion

Throughout designing and making sketching is used for a variety of purposes. Initially, sketches may help to explicate needs, define and clarify the task. Later they are used when exploring ideas, evaluating proposals, identifying design problems and communicating with others. Sketching may also encourage the development of a general design ability.

The study reported here has shown how, when left to their own devices, Year 7 novice designers, whether taught sketching skills or not, do not use it as a way to develop a proposal. Rather, students explore their mental images using three-dimensional materials.

Subjects in this and earlier studies did not view sketching as a mediating instrument between mind and hand. Yet if students are to develop capability in designing and making they must learn the relationship between sketching and thinking, and how to use sketches to clarify and show details of their design thinking.

I am indebted to my colleague Dr. David Barlex, Senior lecturer at Brunel University and Director of Nuffield Design and Technology, for his assistance with the design of this research.

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A Study of the Thinking Mechanism and A Case Study application of the Technology Education in Taiwan Elementary School

National Taichung Teacher College, 140 Ming-Sheng Road, Taichung City, 403 Taiwan R.O.C

Telephone / Facsimile +886-4-2252066. E-mail wys@mail.ntctc.edu.tw

James Yen-shun Wei – Ph.D. student in Industry Arts/Technology education

Introduction

This paper focuses on the different thinking mechanisms which might be developed and used through technology education.

A specific case study, that of designing and making a lantern, shows how these thinking mechanisms are utilised in a real and relevant example.

Setting the context

The manual work/technology education of Taiwan places emphasis on the training of design ability and practical making. It considers the ideas "of to learn by doing" and "mind on and hands on" as very important. To view from the function and performance, it focused on the process of design, the structure of the problem (product), and made use of all kinds of technology media and the match of the aesthetic external, form, and principle to visualize the idea (technology instrument). Lastly, through the making and execution (technology equipment) the work is completed. It actually requires "mind on and hands on", and the building up of the knowledge and capability of technology training.

Thinking procedures

The thinking way of procedure of design may be the same as a practical system model: Demand, Input, Processing, Output, Feedback. Contrast to these thinking models offered in Taiwan's mechanical performance curriculum, which mostly belongs to an applied systematic mode concept and provide the problem solving procedure, these thinking modes are a goal (or finished product) achieved. Problem-solving is the experience of creation which focuses on "change, creation, production", and they are strategy, direction, operation or the creation of game rules. The first step of creation is thinking, which is the passage and capability of the mental activity for problem-solving. The new method to identify problem-solving and the passage for thinking method is called "creative thinking" (Lin Shen-Chuan 1996). Creative thinking is to have a creative idea in the thinking, the operation of the intelligence structure is an "expanded thinking"; and the productive thinking method as a result of "shift". The two capabilities are a source of novel thinking, and novelty is a major characteristic of creative thinking. Problem solving and creative thinking are closely tied.

The process of problem solving requires creative and novel thinking to analyze problems, to collect and apply information, to use multiple ways of thinking, and to be able to see alternative solutions. Therefore, problem solving is beneficiary to creation composition.

The reflection on "human activity" and "products human can make use of" is the reflection and debate "people-object-condition" relationships. The thinking mode of design has uncovered human nature, technology, social, cultural and environmental problems. The positive and negative impact of their influence not only shows the advantage/disadvantage of living, but also builds up the formation of knowledge. The influence of knowledge has provided human beings with a new view, a new method and a new instrument for problem-solving. The manual work/technology education in Taiwan focuses more on the application and development of the technology product.

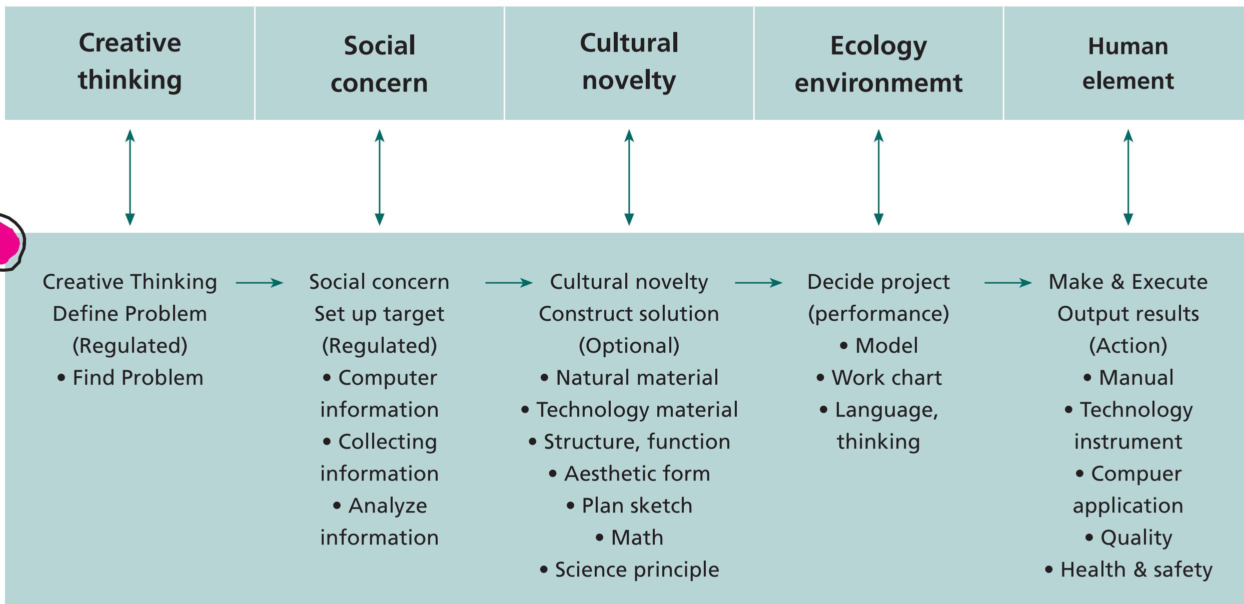


Figure 1 The thinking mechanism of technology education

However, more emphasis on the attached relationship of technology and the product as well as the cultural creation, social concern, ecological environment and human nature elements is very important. To speak from the "people-object-condition" relationships, it is the intensive interaction between human beings and objects. The "people-object-condition" debate shall be examined carefully, so that the reason for technology to exist can be effectively and meaningfully understood. For this reason, to aim at the disassembly and construction of the "people-object-condition", the function that expresses the thinking mode is illustrated as the following:

Apply the systematic mode as the pathway to construct problem solving. The major teaching idea is: practical working procedure, which includes: demand-input (determine the problem, set up the target), handling (construct the solving method, choose the project and the making and execution), output (finished products), pay more attention to the value-oriented human nature, technology, social, cultural and environmental impact on feedback process and the procedure to turn imagination into practical objects. (See Figure 1)

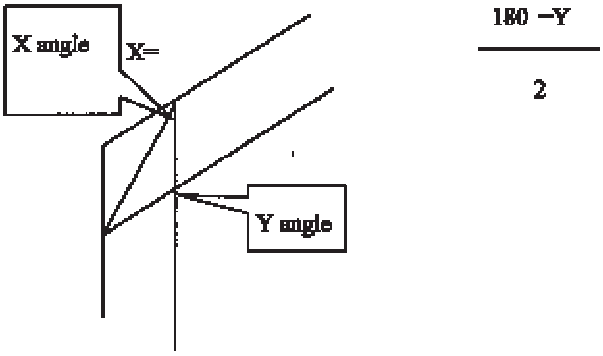
A Case Study and Application

The thinking mechanism of technology education is actively searching for usable media from the surroundings of our lives, applying mathematics, science principle and procedure, or mathematics relations to integrate the speciality of the material, instrument, structure, and function to make creative objects; and to cultivate technology knowledge as well as to concern about the society and ecology. The above mentioned need to be considered when designing and making a modern lantern.

- Description of Activity: Modern Environmental Protection Lantern
  - Contents of Activity: Design and manufacture a new and interesting modern lantern
  - Expected achievement:
    - Understand the folklore meaning of the Lantern Festival
    - To create a non-traditional style lantern
    - Make use of Math principal and exploded drawing method to design and make lantern with various styles, light-generated, portable or can be hanged
    - Understand Math, technology (design and make), to integrate the contents of social and art teaching
- Connecting courses
  - Math principle corollary and calculation (Math)
  - Visual style and aesthetic design (Fine arts)
  - The meaning of the traditional culture of the lantern (Social)
  - The ability for practical technology application (include drawing, structure and function)
- Teaching resource
  - Material: Colored paper (Calendar, board), iron chips
  - Equipment: Pencil, ball pen, knife, glue, scissors, pliers, long ruler (more than 40cm long), and angle measuring gauge
  - Teaching media: Lantern sample, exploded drawing
- Design ability
  - To be able to collect and analyze lantern styles and the procedures used in making them
  - To be able to use math exploration method (please see annex A), to construct lanterns in triangle, square, hexagon, cross shape and irregular shape
  - To select and emphasize on available paper in our daily live according to the demands of structural function
  - Based on style and aesthetic shape principle to design the external of the lantern, or to strengthen the cultural pattern subjects
  - To be able to consider the requirement of the lantern users
  - To be able to examine the partial structure of the lantern to make the process of lantern making much easier
  - To be able to apply the design and making principle of the lantern to change its function and purpose
- Making ability
  - To be able to understand the meaning of the exploded drawing
  - To be able to find the objects that may use the exploded drawing to make. For example: paper box
  - To be able to select suitable material, instrument and equipment
  - To be able to estimate the size of the paper
  - To be able to draw lanterns in triangle, square, hexagon, cross shape and irregular shape
  - To be able to cut the paper and draw the lines
  - To be able to evaluate the structure strength of the material and make appropriate arrangement
  - To be able to decorate the external of the lantern according to the idea of design
  - To be able to use knife or ink-free ball pen to press down along with the visible lines on the paper, be careful not to break the material it will not affect the formation of a shape
- Knowledge and understanding
  - Knowledge: to be able to understand the folklore meaning and cultural cultivation about the Lantern Festival
  - Material and composition: To be able to select proper material and to understand the characteristics of the material
  - Structure: To be able to understand the bearing of the lantern has something to do with the material, also, to be able to improve the used material in order to reinforce the structural function
  - Product application: To investigate, analyze and evaluate other application of lantern, and to explain the characteristic and function on making the lantern
  - Quality: the lantern can contain a bulb and be able to be plugged into a socket or it can contain a candle. The lantern must be able to light up and not catch fire.

Annex A

1 The mathematical principle of the lantern

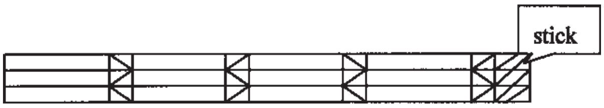


You can utilize the math principle to calculate any type lantern. For example:

The following we take it for simple example

2 The math principle of the lantern exploded drawing

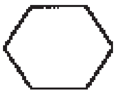
1) Square lantern exploded drawing



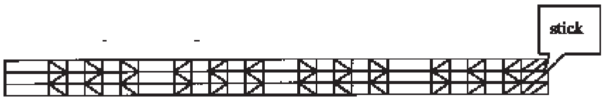
Model is

2) Hexagon lantern exploded drawing

Model is



3) Cross shape lantern exploded drawing.



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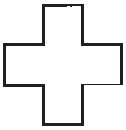

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The Design and Technology Association

Background

The Design and Technology Association (DATA) is the recognised professional association which represents all those involved in design and technology education. DATA is committed to securing, developing and enhancing design and technology in all sectors of education and society and aims to achieve this by:

- *Developing a high quality curriculum concerned with designing and making skills and attitudes which are appropriate to the twenty-first century*
- *Enhancing the quality of teaching and learning in design and technology*
- *Developing positive links with other curriculum areas, especially science, mathematics and art and design*
- *Working with industry and commerce to ensure the benefits of such experiences permeate the curriculum at all levels*
- *Influencing society around us and bringing increased recognition of those involved in designing and making.*

DATA in action

One of DATA's key roles is to keep its members informed. This is achieved by publications (a termly journal newsletter, and specialist materials), regional conferences and a national conference held each year. DATA also provides a telephone support service, and regularly exhibits at all the major exhibitions and events in the educational calendar. DATA contributes to research activities in design and technology and works closely with a wide range of projects to develop curriculum materials and guidance for members. DATA works with other countries in widening our understanding and promoting the international development of design and technology.

Links to support design and technology

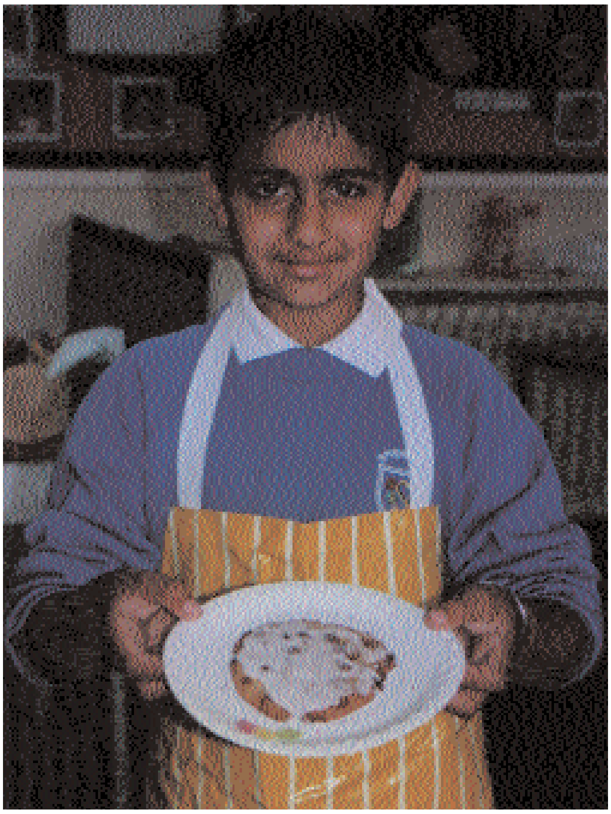
DATA works with all the key organisations involved in design and technology education:

- Government departments and agencies such as OFSTED, SCAA, NCVQ and TTA
- Local Education Authorities, The Engineering Council, The Design Council, SCSST, NCET, TECs and other bodies
- Initial teacher education establishments and In-service education providers
- Other professional associations
- Curriculum development projects
- Industry and commerce – DATA has the support of a number of major companies
- Suppliers of resources for teaching – many are associate members of DATA.

What DATA's members receive

To support its members, DATA provides the following:

- A termly Journal and Newsletter
- A growing list of specialist publications at discount prices
- A free copy of DATA's Directory of Consultants
- An annual conference and AGM
- Special-event conferences to address topical issues
- Professional liability insurance for individual members
- Access to the resources and library at Wellesbourne House.



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Professor Clare Benson
CRIPT at UCE in Birmingham
Faculty of Education
University of Central England in Birmingham
Westbourne Road
Edgbaston Birmingham
B15 3TN

E-mail clare.benson@uce.ac.uk

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