edited by clare benson, suzanne lawson and wesley till

fifth international primary design and technology conference

excellence through enjoyment

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Fifth International Primary Design and Technology Conference –

Excellence through Enjoyment

24th June – 28th June 2005, Birmingham, England

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DEDICATION

This publication is dedicated to Andy Breckon, who supported the creation of CRIPT and its conferences, and has always taken a special interest in primary design and technology, understanding its real value for primary children.

Introduction

We are delighted to host the 5th International Primary Design and Technology Conference, June 24-28th 2005 at the Quality Hotel, Birmingham, UK.

Primary design and technology has continued to grow and develop worldwide in the intervening two years since the last conference. Countries such as Bahrain and Chile are developing new curricula to match the needs of the young people in their countries, whilst countries such as New Zealand are reviewing their well established practice and ensuring that what has developed is still relevant today. The increasing integration of Information and Communication Technology (ICT) is apparent with both young people and practitioners using a wide range of tools in a variety of ways to enhance learning and teaching. Obviously its appropriateness is key to its value in schools, and this is clearly illustrated in some of the papers.

The number of papers submitted continues to grow. This year it has been decided to separate them into two main sections – research and curriculum development/case studies. CRIPT has always placed great value on the inter-relationship between theory and practice, and the conference programme reflects this. It is hoped that by giving participants opportunities to attend a variety of papers and practical workshops and to undertake school visits, they will see the reality of this. As in previous years, we anticipate that this publication will prove a valuable resource for all those involved in the development of the subject worldwide.

Clare Benson / Suzanne Lawson / Wesley Till
June 2005

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Leading the Way

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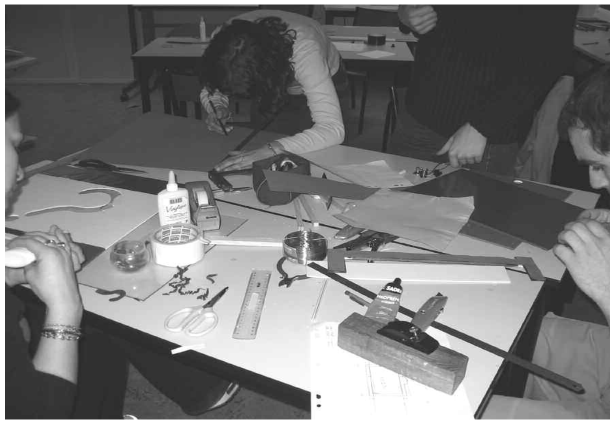
With six of the nine years of compulsory design and technology now taking place in the primary phase, and a review of the Key Stage 3 curriculum about to commence, the role of the subject in the primary phase has never been more important. It is only through developing interest and enthusiasm in the subject during these years that pupils' full design and technological potential can be realised. The need for a consistent and coherent approach to the subject from early years through to 14 and beyond is essential. Approaches to a wide range of issues including, teaching, learning, curriculum planning and organisation, subject leadership, resources and CPD, all require consideration if continuity and progression, both within and across key stages, are to be effective.

The presentation will use findings and examples from the DATA Annual Survey, Ofsted and QCA, to identify the key issues facing the subject in these areas. It will go on to suggest ways in which the subject needs to develop if these issues are to be addressed, including the role of the subject association in supporting primary practice and practitioners.



Assessing Progress in Design and Technology and the QCA 'Futures' Project Agenda

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Ian Williams, Adviser for design and technology

Abstract

In the Qualifications and Curriculum Authority (QCA) Futures Project single sheet report on monitoring the design and technology (D&T) curriculum, which will be available at the CRIPT Conference, I refer to evidence that teachers would appreciate common, nationally recognised advice, support and exemplification on assessing progress in the subject. I am pleased to say that QCA will begin to develop packs of such materials in D&T and other subjects over the coming eighteen months. The packs will address progression from the foundation stage to key stage 3. This paper outlines the issues that will be considered as we address the current needs of teachers and the longer-term forces for change that QCA's 'futures' research has identified.

An outline of the Assessing Progress in D&T materials

The 'Assessing Progress in D&T' materials will use the National Curriculum for England Design and Technology level descriptions (www.qca.org.uk/nc publication ref. DfES/0119/2004) but will provide further support to teachers by unpicking qualities detailed in those descriptions in relatively complex pieces of work. The materials will make it clear to teachers how advice relates to existing guidance in, for example, QCA's National Curriculum in Action website (www.ncaction.org.uk), the Foundation Stage Profile (publication ref. QCA/03/1006), Creativity: find it, promote it website (www.ncaction.org.uk/creativity/ or publication ref. QCA/04/1292).

Clare Benson, Director of the CRIPT team will lead the development of the Primary materials. Her advice will draw on evidence generated in the DfES funded project 'Designerly Thinking in the Foundation Stage'. Clare will share evidence with Richard Kimbell, Director of the Goldsmiths College Technology Education Research Unit (TERU) who, in turn, will share findings from his DfES funded 'Assessing Design Innovation' project as his team develop late Primary and Key Stage 3 units.

The writing team will make it clear how designing, making and assessment processes build on similar foundations in all key stages. Their aim will be to help teachers appreciate the experiences of younger or older pupils and how this underpins a pupils current performance. Some approaches may appear radical but they will clearly support existing practice.

The whole package will include a teachers' guide which will explain the structure of the resource and how to use it. It will include tutor notes for use by specialists and non-specialists that will clarify how the National Curriculum importance of design and technology statement can be addressed in a meaningful way. It will also include links to the QCA 'Customise your Curriculum' website. The site (www.qca.org.uk/schemes) shows how Primary teachers are:

- Adapting units from QCA/DfES schemes of work
- Combining units from different subjects and
- Embedding English and mathematics across the curriculum.

Each section provides principles and ideas on:

- Why? What are the benefits of customising the curriculum in different ways?
- How? What are the ways you might do this? What else do you need to consider?

Advice in the Assessing Progress in D&T teachers guide will hopefully lead to a clearer understanding of what design and technology is through references to the wider designed world. Examples of practical activities that are not D&T will also be provided and suggestions made as to:

1 What would make these activities D&T;
2 How to reject non D&T approaches;
3 Modifying such approaches.

Progression between the units and across key stages will be addressed in all of four units at each key stage (foundation/KS1, KS2 and KS3) representing the full range of D&T focus areas.

Advice given in the units will specifically describe particular elements of D&T activity. This advice will re-confirm the requirements of the National Curriculum Order. It will clarify where designing occurs within making processes i.e. designing involves continuous, reiterative modelling and making processes generate ideas in action.

The materials will provide exemplar evidence of selected pupils achievements and progress with explanatory commentary on:

- Qualities of performance;
- Evidence of performance;
- Making judgements of performance;

and how this can be developed to enhance progression in particular areas of experience.

Strong connections between other subjects will be developed, in particular with science, maths, art and design, ICT in at least one unit in each key stage. Aspects of learning that go across subjects will be considered throughout the exemplification of tangible and empirical evidence.

Futures: meeting the challenge

The project above will support current assessment needs but we must, of course, continue to broaden the debate when considering how we at QCA address the forces for change in longer term curriculum and assessment development. Few would disagree that learners will flourish only if their D&T experience successfully adapts to the needs and changing demands of the time. While there is broad consensus about the underlying aims, purposes and values of D&T as outlined in the National Curriculum *importance of design and technology statement,* and how these are met at least in part in the DfES/QCA Schemes of Work for key stages 1 and 2 units (DfES publication ref. QCA/98/254 1998, revised 2000), we need you to share your views on the best way to organise learning to more fully achieve our goals.

QCA's research identifies the following forces for change within the curriculum:

1 Changes in society and the nature of work
2 The impact of technology
3 New understanding about learning
4 The need for greater personalisation and innovation
5 The increasing international dimension to life and work.

1 Changes in society and the nature of work

Society has, of course, changed significantly in the last 30 years but even in the time that has elapsed since QCA revised the National Curriculum in 1999 monitoring evidence is stressing how we in subject teams should enhance opportunities for children to build and maintain relationships, work productively in teams and communicate effectively in a range of media. We are told that children should build up their confidence as problem-solvers, take responsibility, make decisions and become flexible, adaptable and willing to learn new skills. There are clear opportunities to develop confidence in these areas within D&T but it is becoming more evident that these skills can cross subject boundaries. We have been asked to consider where current delivery of D&T in the primary phase may have to adapt to make more of these opportunities.

The QCA Futures team has asked subject communities to reflect on the skills and knowledge learners will need so that they can flourish and how these can be met. The hope is that we recognise where each subject may address only part of those needs rather than persuading ourselves to justify our subject's existence by trying to cover everything.

2 The impact of technology

Technology permeates children's lives outside school. Investment has been made in many Primary Schools' ICT provision and there are strong ambitions in some quarters for e-learning and e-assessment although QCA funded research in D&T has focussed on the Secondary Phase up to now.

Technology can influence when, where and how children learn. It will be an important driver in the way learning develops and will be increasingly harnessed to support teaching and improve the quality of assessment.

In an increasingly technology-rich world, primary school children need to be given the opportunity to review and modernise what and how they learn. When they progress to secondary school they will learn, for example, how a graphic designer works today compared with 30 years ago. Against this background we must consider what a modernised D&T curriculum should look like. We have been asked by the QCA Futures team to debate if the way we address the content of learning adequately reflects the impact of ICT in D&T contexts.

Most would agree that basic ICT skills are essential but not enough. An e-confident learner is able to make informed decisions about when and how to use these skills to support their learning in D&T. They may use technology as a tool for thinking, making or doing but ICT needs to be used more effectively to help develop learners' enquiry skills, logical reasoning, analytical thinking and creativity. It should support individualised and independent learning, while encouraging wider communication and collaborative learning.

3 New understanding about learning

Although the single page monitoring report that I referred to in the abstract points to evidence that D&T specific initial teacher and in-service training is limited, it is fair to say that for teachers who access research or developments in educational theory, new understanding about how children learn is shaping the way they organise teaching. The QCA Futures: Meeting the challenge pamphlet suggests that:

Developments in neuroscience, for example, provide new insights into the way the brain works. We now know that intelligence is multi-dimensional, that an individual's capacity for learning is linked to their emotional well-being and that people learn in a variety of ways. Research tells us that an individual's self-image as a learner strongly determines their ability to maintain positive relationships and thrive in society and the workplace. When we are thinking about how best to promote this ability in individuals it becomes clear that how learning is organised is as important as what is learned (QCA 2005).

We have been asked to consider the implications of new understanding about learning for the way we might organise D&T experiences, those within other subjects and the curriculum generally.

4 The need for greater personalisation and innovation

The QCA pamphlet also suggests that:

> *The challenge for curriculum designers and subject communities is to identify how greater personalisation of*

learning can be achieved within the context of a national entitlement. We need an approach that allows for innovation and flexibility while guaranteeing an entitlement to high-quality educational outcomes. Some suggest that we should explore new approaches to curriculum development and that less prescription will promote innovation. We might develop a mechanism for feeding dialogue with stakeholders into curriculum evolution (ibid).

We have been asked to consider how a national entitlement might be described and guaranteed in the context of increased choice and personalisation. We have also been asked what mechanisms might be developed to produce a more evolutionary approach to curriculum development.

5 The increasing international dimension to life and work

The pamphlet goes on to state that:

Global issues are part and parcel of young people's lives in a way that they never were in the past. Through television, the internet, ease of travel and diverse communities we are aware of a much wider variety of cultures, religions, art, sport, music and literature. There are new opportunities to widen networks and communities and to broaden learners' experience and knowledge (ibid).

There are many opportunities when investigating and evaluating in the current programme of study for D&T for children to develop their understanding of the global context of their local lives, examine their own values and attitudes in relation to the challenges they face and see how they might play an active role in responding to these challenges. We have, however, been asked to think about how the subject and the wider curriculum might better equip pupils for the roles and responsibilities of global citizenship.

The challenge for assessment

The Assessment of Progress in Design and Technology materials that I referred to in the first section of this paper will address assessment issues within the wider aims and purposes of the subject. Those materials will ensure that measures of performance in the subject are sufficiently wide to guarantee a broad and balanced learning agenda. But the ongoing challenge is to ensure that what we assess keeps up to date with what we want learners to know, do and understand in a rapidly changing world.

I look forward to the opportunity to debate the questions presented in the text over the course of this conference.

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  Customising your curriculum website

What Does an Enrichment Programme Reveal about the Nature of Gifted and Talented Behaviour in Primary School Design and Technology?

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Abstract

A design and technology enrichment programme is proposed as a way to aid teacher nominations in the early identification of student giftedness. A study, initiated by the Wandsworth LEA and carried out by a Brunel University research team, is used to show the way that enrichment programmes, that take place over a period of time, of the sort designed by the Nuffield Design & Technology Project, may be able to facilitate the identification of giftedness. Accordingly, the performance and behaviour of children (and their teachers) inside three primary classrooms are tracked over the span of two-day tasks, and conclusions are made concerning the possibilities of using appropriate enrichment tasks as indicators of, and a means of, nurturing giftedness.

Introduction

Sternburg (2004) states that there now appears to be a consensus amongst researchers concerned with giftedness that identification should not be limited to tests of intelligence, and that a variety of techniques, procedures and instruments ought to be used to identify these students, to differentiate their educational experiences. Furthermore, he proposes that such relatively 'quick' tests are unlikely to get at the complexity of giftedness. He presents the work of early researchers such as Passow as primary examples of the approach that research should now take. His position is that examination of performance and products is necessary for identifying gifted children… and the batteries of instruments and tests that have been developed over the last twenty five years do not fully do this.

Passow and Tannenbaum (1978), argued that enrichment programmes are highly relevant to the current problems and interests of those concerned with the identification of gifted students, because they examine the issue over time, in heightened atmospheres of constructivity:

> *"It is the creation of pupil products which contributes to self-identification, and since product development is a continuous one, identification should be seen as a continuous experience, rather than a single event test administration. Identification of the gifted and talented therefore is related not only to systematic observation and intelligent interpretation of test and observation data, but to the creation of the right kinds of educational opportunities which facilitate self-identification – identification by performance and product which results in the manifestation of gifted or talented behaviours."*
> (Passow and Tannenbaum 1978, p. 16)

Sternberg's notion of the necessity of using a specific enrichment programme to identify elements of giftedness is central to this case study. It grounds the use in this study of the observations in the primary schools in authoritative theory. It investigates the notion, proposed by a prominent researcher in the field, that tracking giftedness through the use of tasks (especially those designed to enrich elements of giftedness), performances and resulting products, should now be regarded as potentially a necessary addition to the identification process.

Background

Davina Salmon, the Primary Gifted and Talented co-ordinator for Wandsworth Local Education Authority in London, England initiated this study. This local authority is rethinking its approach to primary education in response to the government publication Excellence and Enjoyment (Department for Education and Skills 2003) which highlights the following:

- Set high expectations and give every learner confidence that they can succeed
- Establish what learners already know and build on it
- Structure and pace learning experience to make it challenging and enjoyable
- Inspire learning through passion for subject
- Make individuals active partners in their learning
- Develop learning skills and personal qualities

From the Local Education Authority (LEA) perspective the challenge for practitioners is to create the context in which children can develop a learning orientation. In recent years there has been a considerable emphasis on performance with primary schools being ranked in league tables according to the performance of pupils in statutory tests. The LEA has identified clearly the limitations of a performance led culture and contrasted it with the benefits of a learning culture in terms of the learner's orientation to learning. This is summarised in Table 1 (over).

A learning arena for both teachers and pupils

In response to the challenge of developing a learning culture Davina identified design & technology as a subject in which there was considerable 'learning potential' for both teachers and pupils. In her experience there were many teachers in Wandsworth for whom teaching design & technology was a challenge and she wanted some of these to experience learning from the child's perspective as a first step to providing a situation in which the teacher could organise lessons in which the children were learning, as opposed to performing, design and technology. To achieve this Davina collaborated with the Nuffield Design & Technology Project to organise two days of professional development activity in which the teachers carried out four units of work. The units involved the teachers in carrying out the following designing and making activities supported by a tutor.

Table 1	
Learner's orientation to learning	
Performance	**Learning**
• Belief that ability leads to success	• Belief that effort leads to success
• Concern to be seen as able and to perform well in the eyes of others	• Belief in ability to improve and learn
• Gain satisfaction from doing better than others	• Enjoyment of challenging tasks
• 'Learned helplessness' when the task is too difficult or challenging	• Deriving satisfaction from success with difficult tasks, and ability to learn from mistakes • Ability to engage in dialogue with oneself to proceed through a task

Day 1
- What should be stuck to your fridge?
- Design a fridge magnet that is made from layers and is part of a set that will appeal to young children.
- This task is suitable for Year 2
- Should your creature be fierce or friendly?
- Design and make a creature to welcome visitors to, or deter intruders from, the classroom.
- This task is suitable for Year 6

Day 2
- How will your roly poly move?
- Design and make a simple push-along toy (a roly poly) that provides amusement in both its appearance and the way it moves
- This task is suitable for Year 2
- How will your beast open its mouth?
- Design and make a model animal with a moving mouth.
- This task is suitable for Year 5

Davina was convinced that the learning behaviours developed through good quality design & technology provision would have an impact on learning across the curriculum for children of all abilities but she had a particular interest in those children who might be gifted and talented. So the teachers worked with Davina, David Barlex and Tom Balchin on a third day exploring how they would identify gifted and talented pupils in their schools, which units of work they would teach and over what time span they would carry out this teaching. There was general agreement that a drip feed approach, e.g. one – two hours per afternoon across several afternoons was not particularly suitable, partly because such a large proportion of available time was spent 'getting out and putting away' and also because it was difficult for the pupils to immerse themselves in the activity. This has resonance with the findings of others working in the field (Barlex 2001(a), Perry 2003) and also the recommendation of Sternberg (2004) that extended enrichment activities are increasingly being seen as appropriate to assist in the identification of the gifted and talented. Hence it was decided to teach the chosen units of work over two whole days but with a time gap between the days to avoid disruption.

It was not easy for the group to decide on the criteria for selecting pupils who might be considered gifted and talented. After much discussion the following list of criteria was established.
- Can show interest and enthusiasm, are predisposed to engage
- Can show aptitude in using tools and materials
- Can show initiative in following through design ideas
- Can justify choices and decisions made
- Can show willingness to acquire new skills/knowledge
- Can be capable of non-conventional and creative thinking
- Can be an efficient demonstrator of intent and direction of progress
- Show problem solving skills in a particular subject area which has the potential for application in another subject area
- Can show curiosity and intrigues towards artefacts – what they are for and how they work
- Can take ownership of activities

The teachers spent some time discussing the research questions they would try to address in their teaching and although many of the questions were intriguing it was decided that it would be best if they concentrated on teaching the unit with special emphasis on enabling pupils to make design decisions. This would enable a visiting researcher to take photographs and make field notes which could later be explored for data relevant to the research question driving the study i.e. To what extent is gifted and talented behaviour revealed in the work of primary children, identified as gifted and talented by their teachers in design & technology, during an enrichment programme consisting of a two-day immersive design & technology experience?

The teachers decided on the following units of work, selected from the Nuffield Primary Solutions Pack (Barlex D 2001(b))

Teacher A (a mix of year 3 and year 4 children)
- Does this game stop you from being bored?
- Design and make a toy or game that will amuse and intrigue a bed-ridden patient aged approximately 11 years and that can be played with on a bed tray.

Teacher B (a mix of year 4 and year 6 children)

- How fast should your buggy be?
- Design and make a controllable, battery-powered toy vehicle for an identified user

Teacher D (year 4 children)

- How will your beast open its mouth?
- Design and make a model animal with a moving mouth.

Observations

Teacher A specialises in teaching art and engaging her pupils with the highly technical task of designing and making an electrically powered vehicle was a highly challenging endeavour. She responded by taking great pains to learn new technical knowledge but still drew heavily on her specialism. Her approach mirrored that identified by joint Nuffield Curriculum Centre – Qualifications and Curriculum Authority research as supporting creativity (Barlex 2003). She provided stimulus by beginning the task with observational drawing of toy vehicles. She put the work in a context to which the pupils could relate – they would make a buggy for themselves. She carefully structured the building of the basic chassis and electric motor drive so that they learned useful and relevant knowledge and skill. She promoted reflection by organising the children to work in pairs and discuss their work as it progressed. She added intrigue to the work by requiring the children to use an animal of their choice as the basis for the body shell. She gave choice to the pupils over the control and special features they built into their buggies. Her highly structured approach at the beginning coupled with the freedom for the children to make both technical and aesthetic decisions enabled her to manage the risks the children took in developing innovative designs. Each child produced a unique animal based decorative body shell. All the children were keen to assemble a basic working buggy and enjoyed the new experiences of stripping wire and making connections. One pupil in particular who had worked rapidly in producing a basic single motor chassis moved on to produce a chassis with two motors enabling directional control. The task of developing a hand held control unit attached to the buggy by a four wire cable proved demanding and led to the buggies being incomplete by the end of the second day. However all children were engaged and demanded more time to finish.

Teacher B responded to the challenge of providing an enrichment opportunity for her pupils by identifying 8 children from two year groups who may be gifted at design and technology. She provided a context for the two day task, asking probing questions about the need for board games during 'wet-weather breaks'. She drew up charts that the children contributed towards in order to work out criteria for the game. The level of response to such questions was, for her, an indication that she had used sound professional judgement when choosing the children for the task.

Children were encouraged to look at and criticise a selection of existing games, which brought up a number of user-issues the teacher had not expected. They then designed their own board games. Each was a simple idea, not too complicated. The teacher used her communication skills to involve each student, but a constant feature of the programme was its autonomous nature. Each of the children was creative and industrious because they were clearly supported whenever they needed. There was a vast reservoir of resources, and the teacher made it clear that if the children needed anything, she would buy it. This teacher energy, confidence and control of her class showed… children were even allowed to use craft knives. Different stages of development from modelling to final product were characterised by the extreme mess that the classroom became; but the children seemed focussed on their productions. Ups and downs in mood became obvious, as difficulties with the making process emerged.

Teacher D adopted a very structured approach. On the first day he organised and led a series of short tasks that engaged the children with learning about nets, being able to construct nets, making simple mechanisms from wire, constructing legs and feet to support a body shell and ways to give a creature character, On the second day he changed his pedagogical stance completely. He ceased being an instructor and encouraged the children to use what they had learned in developing their own ideas for creatures with moving mouths. Each child responded individually and developed an animal that met his or her own personal criteria. Some members of the group had serious behavioural problems. Several were receiving anger management treatment. The teacher showed great skill in deflating conflicts and providing a calming influence when the tension of over ambitious designing was about to result in tantrums.

Discussion

There were features inside these processes that were recorded, and then further brought out by interview data, which will form the basis for a full paper. These incidences concern the responses of the children to particular events inside the enrichment programme. We found that there were features about the enrichment tasks that drew particular responses from the children. Such responses can be split into two; either 'real time' or 'multi-stage'. Both were found to be indicators of 'differentness'; answers to inputs or events that could be put towards the sum of what it means to be gifted.

In this way, we found that such events ranged from unconscious responses to a teachers' or peers' questions or advice, to the conscious decisions to work in particular ways over a period of time. Impressions were formed by each of the researchers about the particular children, using these critical incidences. We found that many of the children, identified as gifted and talented:

- Posed unforeseen questions
- Generated complex, abstract ideas
- Exhibited feelings and opinions from multiple perspectives
- Inferred and connected concepts
- Initiated projects and extensions of assignments
- Were intense
- Manipulated information
- Guessed and inferred well
- Anticipated and related observations
- Were self-critical.

The above criteria are all strong features of the gifted learner, according to (Szabos 1989), and our observations captured these going on, in a way that single-shot gifted and talented tests probably cannot. This strengthens the argument for using enrichment programmes for identifying gifted and talented to provide support for the teacher when he/she is using professional judgement to nominate gifted and talented pupils. There is also some evidence that gifted and talented -ness is nurtured in the environment of enrichment programmes in which children can experience immersion through the use of extended time. An interesting question for senior managers in primary schools is the extent to which enrichment programmes can be integrated into mainstream schooling.

Conclusion

It is our belief that reflexive or reactive incidences that occur in response to stimuli provided inside enrichment tasks (which take place over a continuous period of time) can inform us about giftedness. Not only do enrichment tasks have the power to reveal behaviour that may be regarded as gifted and talented, in order to compliment, support or check teacher nominations, but they provide an environment in which such behaviour can flourish.

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Never Keep Ideas in Your Head: Elementary Pupils' Views of Portfolios in Technology Education

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Abstract

The study described here investigated elementary pupils' experiences when using design portfolios and the role the portfolio played in their technology education. The research builds on previous work that investigated the use of design portfolios by professional designers, teacher educators and teachers working in England and Canada.

Focus group interviews were held in England with three groups of Year 6 pupils. Questions asked of participants focused on definitions and the advantages and disadvantages of using a portfolio, as well as pupils' understanding of the purposes of a portfolio. Audiotapes of the interviews were transcribed verbatim. Analysis of the data involved thematic analysis and concept analysis.

Analysis of the data has revealed that Year 6 pupils (a) regard the primary purpose of the portfolio as a way to remember ideas, (b) enjoy using portfolios, but (c) are uncertain about the uses of the portfolio. The paper will end by raising questions about the use of portfolios in elementary design and technology education.

Introduction

This paper will report an investigation into the way in which elementary school pupils use portfolios in design and technology education. First, it will review the literature describing how new theories of learning and new assessment practices support the use of a portfolio as a teaching, learning and assessment tool. Second, the paper will describe the method used to collect and analyze data. The third section of the paper will report the results of analysis of the data. Finally the paper raises questions about the use of portfolios in elementary design and technology education.

Review of Literature

In recent years, a number of theoretical and practical reasons have emerged to support the use of portfolios in a range of educational contexts and for a variety of purposes. For example, contemporary views of learning stress that it is an interactive process (Klenowski, 2002) involving reflection, evaluation and the extraction of meaning (Dennison & Kirk, 1990; Shepard, 2000). A new assessment paradigm to support improved learning emphasizes the active involvement of pupils in their own learning, the importance of self and peer assessment, and the provision of feedback to the learner (Assessment Reform Group, 1999). Assessment approaches derived from a quantitative tradition, that is, *Assessment of Learning,* have given way to authentic assessment, *Assessment for Learning,* in which a pupil's ability to use knowledge to perform a task that is similar to or reflects those encountered in life outside school is assessed (Black & Wiliam, 1998; Klenowski, 2002). Burke and Rainbow (1998) describe how a portfolio can be used to provide an evolving picture of pupils' learning and progress in a variety of areas, including technical skills, self-learning, metacognition, improvement over time and establishing next targets.

The use of portfolios is not a new idea for practitioners of design, or for elementary school pupils participating in technology education. But as Klenowski (2002) suggests, "in the promotion of the portfolio for assessment and learning purposes there is the possibility that too much will be promised and in practice a lot less will be accomplished" (p. 9).

Method

The research method employed in this study used a case study design (McMillan & Schumacher, 2001). Participating Year 6 pupils attend a small (311 pupils) Catholic elementary school located in the North-West of England. Twelve purposefully sampled, that is "information-rich cases for study in-depth" (Patton, 2002, p. 46) pupils (6 girls and 6 boys), were randomly divided into mixed-gender groups of four and participated in three separate focus group interviews. The 12 pupils were identified by the headteacher as (a) representing the full range of ability in the school, (b) from a variety of socio-economic backgrounds, and (c) as variously competent in their design and technology lessons. According to Heary & Hennessy (2002) focus groups encourage pupils to provide diverse responses, express their own views and genuinely engage in good quality discussion. According to Yin (1989) small sample size (as in this study) is not a barrier to external validity provided that each case study is detailed and analysis of data reveals elements of practice relevant to the study at hand.

The development of the questions for the focus group interviews and the analysis of data were informed by the work of Morgan (1998). General questions focused on definitions and perceived advantages and disadvantages of using a portfolio. Specific questions focused on the particular purposes of portfolios in the context of the design and technology work of each group. Each focus group lasted a maximum of one hour. A facilitator's guide was used to moderate the interviews (Munby, Lock, Hutchinson, Whitehead & Martin, 1999). Each focus group was audio taped. Tapes were transcribed verbatim. Assigning each pupil a code number ensured confidentiality. The unit of analysis used for coding the transcripts was the individual pupil's response. Concept analysis (Miles & Huberman, 1994; Silverman, 1993) allowed the researchers to identify key categories of statements, which were later used to code the transcripts and derive meaning from the data.

Results

The definition of a portfolio

Pupils described their portfolios (referred to as a design booklet in this school) in the following ways:

> *A design booklet is just like a file … made up of pieces of paper with diagrams, and pictures, and things of the design project you've drawn. (FS3)*

> *You plan and you do a diagram of what you'll use in whatever you're making, and how you're going to make it, and then afterwards you [draw] what it looks like, and you can write about what problems you had or what you'd want to improve in the next one you do … you put things in so you don't lose anything, and you've got pieces of information you can remember and use again maybe. (FS6)*

> *It's a book where you write down your ideas and the object that you're making, and try [to] see if there's any problems … and make them better. (MS10)*

The contents of a portfolio

In response to questions about the contents of a portfolio, pupils were consistent in their responses:

> *Well before you start [making] you include a picture of what you want it to look like, your finished product … what you want it to be, and then you include a description of who it's gonna be for, and then why you're making it, and then at the end you include a picture of what it actually does look like, and if it needs changing from your first one. (FS3)*

When asked what, if anything, they did not include in their portfolio, pupils reported:

> *A sketch of the project … ended up in the bin … because it was only a rough copy … and … we tend to put the like good copy in the folder to show off. (FS3)*

Pupils also identified that they were required to complete two types of writing in their design folder: (a) answering questions posed by the teacher as part of a design specification, often on prepared worksheets that were later glued into the folder, and (b) prose generated by the pupil, often when evaluating a product. When asked which of the two they preferred, pupils' views were summarized by one female pupil, who said, "the back page [the evaluation] because on the front page that's before you actually do the project, so you want to hurry up and get onto designing it." (FS3)

The purposes of a portfolio

When asked why they thought it important to keep and use a portfolio, pupils reported that it served as (a) a record of their ideas (b) a reference to help them make the product, (c) a historical record, and (d) as a source of ideas for future work:

> *The booklet helps ya to design stuff because if you don't write it down, how you gonna do it, how you gonna make the project. (MS1)*

> *If you're doing a different project you can use the skills and stuff from one project for another one. (FS3)*

> *It helps you when you're drawing and making what the model is, to look back and just check over it if you're doing everything right, and after … you can write down things that you'd like to improve or change or … the things that you found difficult. (MS7)*

> *You will write down your problems, and then how you actually sorted it out. (FS5)*

But not all pupils saw the portfolio as an ongoing record of designerly thinking, as evidenced by the following comments:

> *If you start designing it and then you think, I want to change that, you can just rip it out and start over again so that you can get your design to what you really want it to be at the end. (FS2)*

> *Sometimes I just scribble down silly notes and stuff … my very, very first ideas … which I don't put in, and then I like alter them to put them in my book. (FS9)*

In the mind of some pupils there appeared to be confusion about the overall purpose of the portfolio. Some pupils used their portfolio as a job bag, that is, a product development tool (Welch & Barlex, 2004). Others used it as a showcase, a place to exhibit best work:

> *I try to put everything into my design book. (MS1)*

> *We did a sketch of the project we were going to do and that ended up in the bin … because it was only a rough copy … and … we tend to put the like good copy in the folder to show off. (FS3)*

> *I draw a beginning picture and an ending picture, but in the middle it's just in my head… When I change it I don't … draw it, I just … change it in my head. (FS3)*

When asked if the design changes between the beginning picture and the ending picture, this pupil replied:

Not usually, because otherwise there'd be no point in drawing the first one … because … [the first one] has to be the best one you can reach. (FS3)

What do you find easiest and hardest about keeping your portfolio?
Pupils were unanimous that drawing (sketching) is easier than writing prose:

Drawing's the easiest because … you've got to do quite a lot of writing to get all the detail in, but drawing, especially if you label it, gets it through a lot clearer. (FS3)

The pictures are easier because you can just draw pictures out off the top of your head, but writing takes up more thinking and it's hard to get things out that aren't very clear to ya. (MS7)

[Hardest is] all the writing … I don't really tend to look forward to it…. I'd prefer to just tick boxes and do a drawing. (FS3)

[I dislike] the writing because you've done loads of fun stuff in the detailed drawing and making the actual structure … but they give us massive boxes to write in and they expect us to fill it up. (FS11)

How would your folder be different if you could do what you liked?
In the final part of the focus group interview, pupils were asked to describe how they would make their portfolio more useful as a tool to help them during their technology lessons. Pupils were quite clear in their responses:

I'd do two main things if I had my own choice. I'd have a folder which I started at the beginning of school … in reception. And the second thing would be to have it on A3 paper, because I don't think A4 is big enough for a good detailed picture and a lot of writing … and I'd stick photos in … or material … like fabrics. (FS3)

If I was actually a teacher … I would probably give the children more time to actually draw than write because when you draw it gives you a better idea of what the children are thinking, because sometimes they write stuff down, which they didn't really mean because they can't exactly find the right words to explain it, what they meant, and a diagram you can just draw it and then just put little notes down so you don't need to like put it in big words and long sentences or anything. (FS5)

Discussion

Pupils in this study had a very positive attitude toward sketching. Most understood the advantages of sketching and the ways in which it supports their designing. Pupils also showed considerable insight into the use of a portfolio as a tool for teaching and learning. As one female pupil suggested: "when [the pupils] draw it gives [the teacher] a better idea of what the children are thinking." This echoes Porter and Cleland (1995), who describe how a portfolio can not only help the learner understand and extend learning, but also invites the teacher to gain insight into the pupil's learning. In suggesting that "sometimes [pupils] write stuff down, which they didn't really mean because they can't exactly find the right words to explain it, what they meant, and a diagram you can just draw it and then just put little notes down" the pupil was echoing Robbins (1997) who noted that "until you delineate [a] design conception in a drawing you really cannot claim to understand it" (p. 32). Drawings provide an open window into the child's designerly thinking and ample opportunity for the teacher to provide formative feedback to the learner, a critical component of assessment for learning.

However, pupils were critical of the limitations placed upon their folders by the teachers. For example, pupils were not permitted to take their portfolios home unless homework had to be completed. Also, the teacher prescribed, to a large extent, the types of material to be included. As one female pupil (FS3) reported, "you only do your work that you're given in it." Additionally, pupils found it discouraging when a teacher denied them the opportunity to pursue a design proposal because the "design looks far too hard." (FS2)

Pupils wanted to use their folder as a sketchbook (Welch & Barlex, 2004). One pupil (MS1) wanted to "take it on holiday [so that] I could sketch what I want." This comment prompted a second pupil (FS3) to speculate that, "you could sort of make a collage … you could get a postcard of your holiday destination and a photo of the plane and all different things that stuck out to you." Yet another pupil stated that, "the most important things that I would put in would be photographs … because if you're going to Paris and you see … the Eiffel tower, if you're trying to sketch it then it might go wrong." (MS4) These pupils were echoing the ideas of Robinson (1995), who wrote that, "a sketchbook is an Aladdin's cave of visual ideas … a personal visual memory bank that can be used as a resource for … developing ideas" (p. 14). Robinson advocates that pupils should be encouraged to keep a sketchbook so as to function as researchers.

In response to questions about the purposes and utility of their portfolios, most pupils were clear, reporting that it served a range of purposes, including as a record of their ideas, a reference to help them make the product, a historical record, and as a source of ideas for future work. Yet pupils did not universally understand that the portfolio could serve as a tool to help them develop a design solution. Pupils admitted to drawing first ideas and the final product, but often product development was conducted "in my head." While some pupils used their portfolio as a job bag, a collection of everything to do with a specific project, others used their portfolio as a showcase in which only "final ideas" or "best drawings" were stored (Welch & Barlex, 2004).

Conclusion

The pupils participating in this study clearly enjoyed their technology education lessons. Pupils enjoyed the opportunity to develop and use a design portfolio and to design their own products. Yet some pupils were uncertain about the purposes of the portfolio and were not provided the opportunity, or taught the skills, to use a portfolio as a product development tool. If portfolios are to become an important aspect of learning, teaching and assessment in elementary technology education, then it would be helpful if pupils were to receive appropriate instruction and given the opportunity to learn and develop the requisite skills. These findings have given rise to a number of questions. What is the nature of the guided instruction required by pupils? What professional development must be provided for teachers so that portfolio use can be optimized in the elementary technology classroom? How can elementary teachers reconcile the three purposes of the portfolio: as a leaning tool, as a teaching tool and as an assessment tool? How can pupils be taught to use different types of folio to serve different purposes? What instruction needs to occur to encourage pupils to regard the portfolio not only as a repository if their work, but as a tool that can help them develop design ideas?

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Developing Designerly Thinking in the Foundation Stage-Perceived impact on Teachers' Practice and Children's Learning

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Abstract

During 2003-4, the Department for Education and Skills (DfES) funded a large scale project relating to the development of practice of Foundation Stage (3-5 years) teachers in design and technology. Twenty tutors and four hundred teachers were involved in the project in Local Education Authorities (LEA) throughout England. Within the Foundation Stage, children undertake design and technology activity, but it is not a separate subject; it is integrated into the six areas of learning-the Early Learning Goals – that form the framework for the Foundation Stage curriculum. Research has shown that few experiences are offered to young children relating to the designed and made world, and in particular the design element is neglected. This action research project was therefore based around this 'gap'; a programme was devised related to the designed and made world; and this paper seeks to discuss some of the findings relating to impact on both teachers and children.

Introduction

Following on from research undertaken for Qualification and Curriculum Authority (QCA) (Benson 2003a) and the Designerly thinking project (Benson 2003b), it was apparent that children in many Foundation Stage settings were not exploring and investigating the designed and made world through teacher initiated activities. The aims and purpose of the project 'Designerly thinking in the Foundation Stage' have been outlined in detail in a previous paper (Benson 2003b). This not only meant that teachers were not fulfilling the requirements of the Foundation Stage curriculum, but the children in their classes were not being involved in activities which might stimulate their curiosity.

Action research methodology

Whilst the funding was given for a curriculum development project, this was set up in such a way as to be able to carry it out as an action research based project. (Bassey 1998, Frost 2002, Bell 1999, Costello 2003) The initial work for QCA had provided the evidence to confirm that there were areas that were not being covered adequately in the Foundation Stage curriculum, and that there was discontinuity between Foundation Stage and Key Stage 1 (5-7 years) in relation to designerly and technological activity. This has been further documented by Office for Standards in Education (OFSTED 2003) reports across the whole curriculum. From these original findings a programme for teacher's continuing professional development (CPD) was created to include the development of:

- Understanding of the nature of design and technology
- Understanding of how design and technology can be incorporated into the Foundation Stage curriculum
- Questioning skills
- Understanding of areas that could be used and developed for designerly thinking.

All participants were expected to undertake 3 activities based around some of the products that they were given, during their professional development day, and to write these up. As the sample of participants was large (400) it was decided that the most effective way of collecting evidence was through questionnaires (Oppenheim 1992) and a document into which the teachers could record their activities. It was hoped that the document would support 'reflection-in action' in which the experience of surprise is crucial (Schon 1983) This included planning, key questions, their teaching strategies, the children's responses, the perceived impact that the project had had on their practice, that of others in their settings, and on the children. In addition, many of the teachers included photos, examples of children's work, and quotes from children. It would also have been useful support the paper based evidence through telephone/face to face interviews with a sample of teachers and to include views of other staff in the schools. However because of time and funding constraints this was not possible to achieve with a large random sample. Follow-up did occur with a number of participants, one of which is presenting a paper at this conference (Taylor 2005). Nevertheless it is possible from the analysis of such a large paper-based evidence to draw out some useful findings which can be considered.

Findings and discussion

From the evidence, numerous strands could be explored but for this paper the chosen areas are:

- Perceived impact by the teachers on their practice
- Perceived impact on the children and their learning

The information that was gathered is immense and the following are just a few key issues from the analysis of the data.

Perceived impact by the teachers on their practice

98% of all teachers responded to the follow-up activities that they were asked to undertake, and most teachers reflected in detail on their practice, including changes to practice that they made as a result of their learning through the project. Majority indicated this was due to the increase in confidence and knowledge and understanding they had gained.

With regard to aims for each session, one teacher's comments characterises those of the majority:

> *"to allow me to develop my teaching using prompt questions (lower and higher order) to encourage a designerly way of thinking from the children"*

and

"to encourage children to look at a product with new eyes again and again and to allow them to make predictions and ask their own questions".

and for the final session (out of 3)

"to see if the children begin to use 'designer' questions spontaneously"

The activities were fitted into the curriculum in different ways. The use of the product was most commonly fitted into a speaking and listening session; other ways were as an activity in its own right or as part of a series of sessions that did result in the children having an opportunity to make a product with a user and purpose in mind. The introduction of structured questioning (Bloom's taxonomy) was an important element in the planning. Whilst many of the questions could be considered those that might develop lower order thinking skills, there was clear evidence that some were focused on evaluation, analysis, and synthesis. Certainly a majority of teachers indicated that they had not thought about questioning in such depth before.

As changes were made to planning, resulting changes in teaching took place. Teachers reflected on the 'clear focus' that the session had, their awareness of the need to give children more time to 'play', to formulate questions, that they could take this "stand alone" activity and use it for supporting language development, and use circle time for exploring products. Realisation that using a product first gave the children a focus and a starting point for their own ideas was common.

One teacher summed up the thoughts of the majority

" this project has developed my confidence and knowledge and understanding and allowed me to do a 'one off' activity without feeling the pressure to feel that it should lead onto somewhere else, such as making. Sometimes the children chose to take this on in child initiated activities and that was great but not essential. So much developed from one activity-language, questioning, developing thinking skills…

It has allowed me to introduce better questioning throughout the curriculum."

Perceived impact on the children and their learning

Over 95% of teachers had identified that they had included little or indeed nothing that related to the designed and made world in a designerly way before the project, so for majority of children this was the first time that they had experienced activities that focused on this area. Four of the main areas that were identified by majority of teachers where it was felt that new learning had taken place were spoken language and the use of appropriate technical language, understanding of key design elements of a product, observational skills and the children's ability to ask questions.

Spoken language and the use of appropriate technical language

Over 95% of teachers indicated that a significant majority of children they worked with were highly motivated by the product they were shown. Interestingly, many of the children, who were most enthusiastic, were those who were often slow to respond and interact in teacher initiated sessions normally. Of course new experiences can motivate, but it was the handling of an everyday object in this way that kept them on task. It also motivated them to contribute to speaking in a way that they had not done before. The children were quick to pick up the new vocabulary that was being introduced and continued to use it in other contexts.

"Child A had rarely offered ideas, but it was hard to persuade him to allow others the chance to contribute".

"Child B offered odd words for the first time in a group".

"Child C talked about wheels and axles and used the terms appropriately. Although he is always playing with cars and kits it is the first time that he had expressed himself in this way".

Understanding of key design elements of a product

As majority of the children had had few opportunities to explore products in this way, there had been little discussion relating to design elements. Majority of teachers commented on the way in which the children appeared to have a very good understanding of user and purpose. Teachers felt this was partly due to the fact that the product was something they could relate to.

Teacher (T1) *"very good understanding of why plastic was used and why some other materials would be unsafe or too heavy/light/squashy etc."*

(T2) *"they suggested an adult would wear it as it was large, but one could be made for a child. It would need to be smaller"*

(T3) *"you couldn't wear these out as there is only one (glove)."*

(T4) *"the children discussed different ways of joining-what would stick well, what would be safe…"*

Child (C1) the flap is "strong enough so you don't rip it when you read it except the pop up picture (at the end)-you could rip that"

(T5) *"all the children were definitely beginning to evaluate other similar products. When some were brought in from home, they talked about the hinges and flaps and why they were put in the books. They identified some as having a good movement in the picture; others were not good "the hinge should move the flap up-it would be better that way. The box lid opens that way"."*

(T6) *"The children understood that often we design and make things in life to make it easier for us-'so the tipper truck can move the rubbish instead of us and it would take a very long time'".*

Observational skills

Whilst young children are encouraged to look carefully at the natural world, it was apparent that this had not been carried into the designed and made world. There are obviously links between the two; certainly material is one area. Comments from the teachers indicated that certain children that looked at the products offered to them, did so more carefully than, for example, at natural materials, or flora and fauna. The children's attention was sustained for longer and many had definite views about why materials/structures/mechanisms had been used and how they might change them.

One example given by a teacher related to hinges. The children had looked at the hinges in the book and were then asked to look round their room and find objects with hinges, when they moved away from the table and moved to different activities. They were asked to keep their own idea a secret till the end of the morning, when they could then share them with everyone. Almost every child had found something, and many spent about fifteen minutes engaged in the task, which was a surprise to the teacher. Only one child indicated something that was not hinged; discussion followed with both teacher and children and the child went away and immediately brought a hinged biscuit tin to show everyone.

(T7) *"Having given some detailed observations about the safety glasses, the children followed this up of their own accord by making comparisons between these and my glasses. They noticed differences such as the glass/plastic lenses and suggested that the plastic was better for safety glasses as it would not break easily into lots of pieces if chips of wood hit it. They noticed the 'flaps' on the side of the safety glasses and said that they would stop things falling through gaps and into eyes. The child that suggested this had hardly ever spoken in a sentence before."*

Ability to ask questions

This was an area that many of the teachers themselves felt that they had not explored in depth in their own practice. However, having included a range of questions in their teaching (open/closed; lower/higher order) it was apparent even after a few sessions that children were beginning to assimilate these and to ask these types of questions themselves.

(T8) *"made me realise that more modelling of language and questions in particular is needed to support the children's development".*

(T9) *"children also began to devise and ask own questions after several sessions which was really a new development for many"*

The importance of role modelling language is vital. (REPEY 2002)

Concluding comments

Two final comments relating to impact on children's learning was the inclusion in every return from the teacher of a comment such as, there was "great enthusiasm, "great excitement", "enjoyment", "high motivation" "they couldn't wait till the next time", "she never gets involved, but she did this time" throughout.

The children's perception of these activities is indicated in the following comment:

"the children decided that to make a book like the one they looked at was very hard but decided that they could if they helped each other, shared ideas because 'it would be really, really hard and you would need at least 6 brains, not like counting'".

Certainly the excellence through the enjoyment from all the work undertaken was clearly evident in the responses from both children and teachers.

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A Case Study Relating to Food Containers with four-year-old's in an Infant School in France

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Abstract

Activities involving the study and production of objects appear on the curriculum for each cycle of a primary school in France. The curriculum does not specify the type of technological object to be studied, or the technological functions to be dealt with, the materials to be manipulated or the techniques to be used, any more than the concepts to be formed. It is left to the teachers to exercise their discretion and make the choice. They look at the complexity of technological objects to be studied and vary the way in which knowledge is passed on by varying the way in which study is organised from one cycle to another. These choices are of interest to teaching and training professionals.

The purpose of this study is to present a sequence devoted to studying containers and packaging of foodstuffs in France during the first cycle of primary school with 4-year-old pupils.

1 Teaching at Primary School – Approaches and Concepts

Activities involving the study and production of objects appear on the curriculum for all three cycles of primary school in France. They are prescribed in the context of activities to discover the world of objects in cycle 1, then in the context of production and technological creation activities in cycle 2 and, finally, in the context of activities involving dismantling products and the production of objects in cycle 3. The curriculum does not specify the type of technological object to be produced or studied, nor the technological functions to be dealt with, the materials to be manipulated or the techniques to be used, any more than the concepts to be formed. The school leaves this to the teachers' discretion.

As a rule, teachers choose the technological object around which the activity will revolve and the concepts to be used either alone, or as part of a pedagogical team. The choice is made in accordance with the curriculum and by referring to a senior representative of the discipline.

Two types of approaches co-exist: The first studies an object, or family of objects that fulfil the same function, or possibly a technological system. These objects are observed and manipulated. The second aims to carry out an object project. This approach involves designing an object, researching solutions and producing it. These two approaches emerge as potentially fundamental concepts for the teachers (Benson 1998, 1999; Chatoney 1999; Welch & Sook 1999, Merle 2000). They place study and production activities in a field that is consistent with the reality of contemporary technology (Ginestié 1999; Blandow 1997; de Vries 1995). There is the concept of building school tasks which integrate elements that involve taking account of the constraints imposed by materials, time and techniques (Benson 1998; Chatoney 2003; Lutz, 1999). There is also the concept of thinking about the action, then organising and planning it before starting on it. There is also the concept of evaluating the result obtained both during and at the end of the process, on the one hand, by comparing it with the expected use and, on the other hand, by comparing it directly with predictions made during the study and design, or by experimentation.

In terms of the fundamental learning process, the usefulness of activities involving the study and production of a technological object is very clear. The study leads the pupil to ask questions about the object to be made (what are its functions? how will it function? where will it be used? what are the constraints to which it will be subjected, etc.), to describe its structure and the forms of the elements which ensure its functionality, and also to compare techniques to be used for assembly or transmission, and to compare materials, etc. Production work gives rise to further questions, concerning the work station, the use of technological manoeuvres and safety measures, the application of procedures and the way in which production activities have been thought through. In addition to these two approaches, there is work on formalised language (Fleer, 1992; Parkinson, 1999; 2000; Nonnon, 2001).

The organisation of technological activities is dependent on a number of parameters: local parameters that prevail within the class, parameters associated with the object itself and didactic parameters.

- Local parameters associated with the class relate to the pupils' ability to read, measure, concentrate for as long as required on a particular task, write, trace and many other skills; or associated with the size of the class, its independence and the equipment available.
- Parameters associated with the object relate to the level of complexity of the technological object. An apparently simple technological object is not necessarily straightforward to study. Whatever the object to be studied, the teachers look at the functions and functionality of the object, according certain functions, for example, more or less importance, or reducing their number. They also look at the complexity of the structure through the choice of assembly techniques, materials or the number of elements to be assembled. Finally, they can look at the assembly techniques by varying the equipment, the materials, the tools or the organisation of the production work.
- The didactic parameters relate to the teacher's strategy and his/her intentions. Teachers are concerned with the dissemination of knowledge: the way in which an object to be studied is introduced, the organisation and type of tasks, the level of cognitive difficulties and the evaluation.

How do teachers orchestrate learning? What choices do they make? Which types of task do they prefer? How do they distribute the cognitive load and how do they make an evaluation?

The best means that we have found of dealing with this question is to observe a sequence in a normal class, and see the choices *put to the test* by the teachers.

2 Context of the Observation and Method

We decided to present a practical class exercise centred on a family of objects all of which fulfil the function "to contain food". This choice of function was not made by chance. This function is an area of study which is not often dealt with from a scientific and technological viewpoint at primary school. It raises issues of unnecessary bulk, of the relationship between container and contents, of materials, of impermeability, of assembly, and of opening and closing. It refers to packaging and to the problem of recycling household waste, a topical issue which is often dealt with by teachers in the context of sustainable development and environmental protection. Teachers conduct numerous activities on selective sorting, or environmental protection. The decision to restrict the study to foodstuffs was the teacher's. It provides an opportunity to place pedagogic action at the level of understanding of a very young audience. Children are familiar with food packaging and food containers, they participate in shopping expeditions, often help with preparing and storing food products. It also provides an opportunity to simplify the creation of a family of objects, simplifying, in particular, the collection of containers and their return to the pupils' parents.

The study is the result of observing a group of four-year-olds at primary school, studying packaging for foodstuffs.

The sequence has been videoed. It is followed by an undirected interview with the teacher who devised and carried out the sequence.

We will present the activity as it took place. The strategy, the knowledge of games, the tools and the techniques used provide an opportunity to watch the teacher in action. The linguistic exchanges and the gestures of the audience provide an opportunity to watch the pupils in action, although the activity does not permit a detailed analysis of the pupils' activity.

The interview complements and provides valuable information about the teacher's activity.

> *The data-gathering (film and interview) is only a small part of a current study to analyse the professional activity of teachers.*

3 A Study of Packaging for Foodstuffs at Primary School (4 Year Olds)

3.1 Aim of the sequence and how it was organised

The project took place over two sessions, several days apart. It involved the observation and handling of containers used in the kitchen, all of which are used to contain foodstuffs. The collection consisted of:

- Commercial boxes of biscuits, cereals and pasta, made from cardboard or paper.
- Commercial metal tins of tea and sugar, together with their lids
- An unopened tin of canned food
- Butter dishes made of glass, together with lids
- All-plastic containers of preserved, cooked food, together with lids
- Wooden salt and spice containers

All of the empty food containers were collected in advance by the children's parents. All the tins were made of the same material. The only tin that was not empty was the tin of canned food.

The aim was to let the children see that containers are made from different materials according to their contents; that the material and the content are linked through their properties; but also to let them see that there are many methods of closing the containers and that some containers cannot be closed again (as with the tin of canned food, or the boxes of biscuits).

To start with, the pupils have to identify and name the materials and their origin. Then they identify and name different methods of closing system.

In view of the number of pupils (more than 20) and the nature of the activity, the teacher sets them to work in groups. The observation relates to a group of 9 pupils.

3.2 Activities of the teacher and activities of the pupils during the first session (50 minutes)

The teacher gathers the pupils around her. They sit on a bench and she empties out in front of them the bag used to store the containers they have brought.

- Observation:
  – *"We'll start by having a good look at these containers"*
  The pupils are allowed to handle the containers for several minutes, and they talk amongst themselves and with the teacher, expressing amusement at the size of some containers compared with others, or at their shape.
  – The teacher allows them time to do this, then examines the containers one by one to get the pupils to talk about the contents.
  "What's this one used for?" "biscuits, are they soft or hard?"
  Observation: the objects can be dismantled into their component parts (base and cover). The "containing" function is repeated as many times as there are containers. This shows the pupils that they are going to have to pay attention to the contents, even though they have been removed. The content is named, then characterised by its properties in terms of state and form (dry, hard, liquid, soft, big, small, etc.).
- Oral expression and vocabulary:
  – *"How can we sort the containers?"*
  The pupils spontaneously suggest classifying them by size.
  – *"How can we sort them other than by size?"*
  The pupils do not make any more suggestions.
  Observation: The teacher introduces the study by emphasising what the pupils know. Then, in another question, she makes it clear that they are going to have to learn something more in order to carry out the task she has set them.
  – The teacher questions them all in turn and asks them to touch the containers. She holds back the keener pupils in order to give everyone the same amount of time to speak and ensure that everyone has understood.
  – The pupils touch the containers to try to differentiate them. Again, they compare size and shape and then, in response to further questioning, distinguish them by the presence of a window in the container *"you can see through that", "There's a hole",* and by its properties *"it's hard", "It's big".*
- Verification:
  – The teacher satisfies herself that they are capable of attributing certain properties to certain materials:
  "To you?", "And what about that one?", "What do your fingers tell you?". "Look, that's tearing".
  – The pupils handle the containers several times and talk about the properties of the materials. *"It's red and blue", "there's writing on it", "it's smooth", "it's hard".*
  Observation: The total number of comments from the children makes it possible to obtain other suggestions, including identification according to the properties of the materials. We can see that, with very young children, the material is not a spontaneous identification criterion.
- Oral expression and vocabulary:
  – The teacher asks them to name the materials.
  "OK, now that we've had a good look at the containers, we'll put them all back here".
  – She once more puts the containers in a heap. *"We can classify them by size";* she does that; *"by colour"*
  The pupils have just been handling the containers with the teacher. They are hesitant.
  – She repeats all the previous suggestions made by the pupils, with their help. *"And can we classify them in any other way?"*
  Stimulated by questions, the pupils start to suggest another way of classification: first glass, then wood…
  – Each suggestion is reinforced and named *"Yes, we can classify by ???" …"Who remembers what this is called?"…*
- Validation:
  – *"by glass"*
  The pupils then sort very quickly, enjoying themselves: cardboard, metal and plastic. The sorting task is executed correctly, the new language acquired is used spontaneously by two pupils.
  Observation: The teacher confirms each classification by giving it a name. Two of the pupils pick this up, and use the name of the material. The others have only taken this in, but are capable of naming it if the teacher insists.
- Articulation:
  – *"You've worked well. Now we're going to see where glass, wood and cardboard, etc. come from".* The teacher points in turn to the piles that have been classified by material.
- Oral expression:
  – *"Where does that one come from?"*
  Apart from wood, the pupils do not know the origin of the materials. So the teacher gets out some posters on which she has drawn grains of sand for glass, a tree and some plants for the cardboard, a mine and a factory for the metal, a layer of petroleum and a factory for the plastic.
  – The pupils look at the illustrations, decipher them with the teacher's help and then repeat what the teacher says.

Observation: To impart this knowledge, the teacher takes care to link the heap of containers to the matching illustration. The vocabulary is simple. The use of image is a means of backing up the teacher's spoken language, which is rich and not easy for four-year-olds to understand. They have an idea of a mine and a factory through the story of Snow White and the seven dwarfs. The pupils are very attentive.

- Articulation:
  – *"Now let's mix everything up".* With the help of the pupils, she mixes up all the piles, which the pupils thoroughly enjoy.
- Verification:
  – The teacher would like to evaluate what has been learned about the origin of the materials. She asks the pupils to join her around a big table, on one side of which she has placed labels with the name of a material written in large letters, together with a drawing of the origin and, on the other side, large blank sheets of paper.
  "We're going to play a game now. On each sheet of paper, you have to put a container along with the label that matches the material from which the container is made. Everyone go and find a container that you like and then get the correct label and put it on the blank sheet. Make sure that there is only one sheet for each material".
  – The pupils do as they are asked, come back round the table, and put the containers and labels on the poster that forms the basis for the classification. They go back to pick up another container and so on until there are none left.
  Observation: the pupils are all happy to participate in this task, which is presented as a game. One or two hesitate in choosing a label. But few errors are made.
- Keeping a record of the activity on materials:
  – The teacher wants to keep a record of the activity, and let the parents know what she has done.
  "We haven't finished yet. Now we have to show mummy and daddy what we have done. We're going to make a big poster to put on the wall by the front door." She asks the pupils to stick just one box on each materials page. She entrusts this task only to certain pupils.

  – The pupil is called out, s/he takes the sticky tape that the teacher has cut and attaches the box of his/her choice.
  – Then the teacher gets all the children together to say what is written on the poster. This is the end of the first session.
  Observation: In this way, the teacher takes care to establish a relationship with her work colleagues and with parents. She is communicating with the world outside her class.

3.3 Teacher's activities and pupils' activities during the second session (20 minutes)

The session starts with the same activity as for the first session. The pupils are put in the place where the sorting took place, and they observe and handle the containers. Some of them remember the name of the material.

- Observation
  – After a while, the teacher puts all the containers together in the middle of the space.
  "Today we're going to see how the food stays in the container. What enables it to stay in the container?"
  – The pupils pick up the containers. They point to the opening and play with the flaps and lids.
  Observation: the teacher introduces the object of the study by the "to contain food" function.
- Oral expression and vocabulary:
  – Now that the systems have been identified, they have to be named: "We are going to see how the container opens and whether or not it can be closed again".
  The teacher talks about the systems and verbalises each action that makes opening and closing possible. Some containers, such as biscuit boxes, do not close by placing one flap over the other, others do, but have a notch which makes it possible for the container to stay shut, others have separate lids which slot on, as with the plastic containers, others have lids screw-on lids, like drinking chocolate containers, yet another has a lid which the teacher removes, but which cannot be replaced, like the tin. There is talk about the contents of the container. This is related to the quality of the closing mechanism.
  – The pupils watch and listen, repeating without being asked, and make comments *"the biscuit can fall out", "it's leaking".*
- Manipulation:
  – Each of the pupils is asked to choose a container, to observe and manipulate the closing mechanism, and to name it. They do this one after another, then put their containers down.
  Observation: The teacher takes care to make a connection between the container and the contents for the pupils. In so doing, she raises the issue of the quality of the closure mechanism, namely its impermeability. The pupils learn by imitation.
- Articulation:
  – Once the systems have been carefully observed, named and used, they must now be classified.
  – The teacher gathers the pupils around a large table on which she has placed large blank sheets of paper. On another table are illustrations which represent the closure system (strips, tabs, lid) and on another the types of closure (screw-on, slot-on, one flap over another, snap-on).
- Sorting the containers according to the closure system.
  – The teacher asks the pupils to match a closure system with its illustration.
  – The pupils each take a container of their choice, observe and

identify the closure system by handling it and pick up the matching illustration. They then put down the container and the matching illustration on each blank sheet of paper.

– The teacher watches. She intervenes only if the situation has come to a halt.

Observation: The teacher withdraws completely from the task. This technique obliges the pupils to take charge of their new knowledge.

- Keeping a record of the activity on materials.

  – Assisted by the pupils, the teacher sticks the matching illustration at the top of each poster and affixes one or two containers below.

  – The pupils name each closure system.

  Observation: the teacher devotes a little more time to saying the name of the closure to each child to consolidate the new vocabulary. It should be noted that this vocabulary is not evaluated.

The study of the sequence shows the choice of tasks and the logic used by the teacher. Her knowledge of games, tools and techniques is clearly identifiable. Moreover, analysis shows how the teacher regulates and adapts her teaching to the needs of her pupils. This permanent adaptation enables her to "keep control" and so achieve her objectives.

4 The Interview

The undirected interview lasts between 15 and 20 minutes. It provides information about, and specifies, the teacher's activity. It teaches us that:

- Technology sequences are scheduled throughout the year. This one took place intentionally before the Christmas holidays because the activity provides an opportunity to deviate from normal classes, which is a welcome change at the end of term, because both pupils and teachers are tired.
- The sequences involve working as a team. In this school, the teachers share the work of devising themed projects (on water, wind, objects, etc.) and communicate their experience to those who will be conducting the theme after them.

In this way, the teacher's activity takes account of human and relational factors associated with other factors such as fatigue, the need to vary pedagogical action or to share the preparatory work to avoid being exhausted by it.

The interview also teaches us that:

- Technology is omnipresent at infant school. Object study is, as a rule, introduced by observing an object, a game, an instrument. Creating an object is usually introduced by a story. Equal use is made of the two.
- Many events can provide the motivation to create or study an object: a festival, a school project, an outing, an object brought in by a pupil, or a problem encountered in using an object, or the discussion of such a problem. It is left to the teacher to decide. Technology sequences are organised frequently.

The interview confirms the observation and states the reasons for the teacher's choice. Consequently:

- the sequence always starts with an adaptation, or even a delaying stage, because the action is often slow. It is followed by attempts to identify problems. However, identifying problems is not always easy because it is very time-consuming.
- Stimulation by the use of question and answer sessions provides an opportunity to remain within the allotted time.
- It is possible to entrust tasks to very small children. Organisation of the pupils' work is always in the context of workshops. This is not specific to technology.
- Observation together with manipulation facilitates the pupil's work.
- The level of language is intentionally informal and technical; childish language is not allowed, even for explanations.
- Drawing, as well as writing, is an essential element of communication at this age.
- Comparison of results is carried out orally.
- Sharing the experience is carried out orally, more often than not. It may be written, as with the production of the poster in this case, but this is not always the case.

The teacher has constructed a teaching model for herself adapted to infant school.

5 Conclusion

This study shows a practical class exercise at infant school and the activity it engenders. The study of containers for foodstuffs permits two highly technological concepts to be considered: the concept of materials and the technological system used to close the containers. Approaching materials by studying a family of objects does not allow questions to be asked about the material in terms of how its shape is achieved or the technique used, as would be possible in a project where an item is created. In fact, the material is identified in terms of its raw material. Work on the origin of materials allows some discussion of how the raw material is converted into a processed material. Once the containers have been selected, the "observation-classification-handling" method and the points raised contribute to the quality of the work of these pupils in identifying the materials and the opening systems. The activity reinforces linguistic ability. The situation enriches the pupils' vocabulary; they absorb the new vocabulary.

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Arguing for the Development of Technological Literacy

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Abstract

There is more than ever before a growing need to understand the "character of contemporary life" (Borgman, 1984). We are transforming our world at an alarming rate and in so doing, we are alienating ourselves from it. Our technologically mediated existence is threatening the very democratic process itself. We need to develop a new language, a new literacy in order to both understand our brave new world, and learn how to live a meaningful existence in it. Where better to start this new literacy than in technology education.

In this paper I will present an argument as to why we need to develop a technological literacy in technology education at school level. More questions will be raised than answers given; I do not have all the answers. I just hope to awaken the debate.

Introduction

> *"Technological literacy is a term of little meaning and many meanings"* (Todd, 1991)

There is very little literature, nor engagement in the classroom, directly relating to education about the basic technological nature of the world that young people must negotiate, nor about the kinds of technological obstacles that they are likely to encounter in that world. Their views of technology influence their ability to both use and relate to it. Many young people have a tendency to perceive technology in terms of its artefacts: computers, cars, televisions, toasters, pesticides, flu shots, solar cells, genetically engineered tomatoes and so on. Often they do not see technology in terms of the knowledge and processes that create these artefacts, nor, in particular, are they aware of the various implications for society which result from the existence of these technologies (ITEA, 2000).

In this paper, I will argue that the predominant focus in design and technology education tends more towards the development of knowledge relating to the artefacts and the processes that create them, and that this is at the expense, and to some extent, replaces, the development of a critical awareness in children of the technologically mediated world they inhabit and the way in which their future lives are, and will be shaped by it. Whilst I make this argument in general terms, I wish to emphasise the importance of engaging children in the primary sector in this process.

Defining technology in the 21st Century

Feenberg argues that in the modern context technology:

> *"appears as purely instrumental, as value free. It does not respond to inherent purposes, but is merely a means serving subjective goals. For modern common sense, means and ends are independent of each other: "Guns don't kill people, people kill people." Guns are a means independent of the users' ends, whether it be to rob a bank or to enforce the law. Technology, we say, is neutral, meaning that it has no preference as between the various possible uses to which it can be put. This "instrumentalist" philosophy of technology is a spontaneous product of our civilization, assumed unreflectively by most people" (Forthcoming).*

It is this unreflectivity, this lack of a discourse, this missing literacy that essentially reduces the concept of technology to that of basic raw materials; to stuff that we will transform into artefacts that we perceive as being necessary for our needs and wants. In this definition, we control and exploit the world to our own ends, and we continually get better at doing it. Heidegger (1962) saw this reductive, unreflective view of technology as akin to 'calculative thought'. Modern civilisation can transform the world because 'we have the technology'. This, some will argue, is our destiny. Paradoxically, I contend that the more technologically advanced we get the more we actually live apart from the world and, disturbingly, from each other as well. Borgmann (1984) illustrates this through his "device paradigm theory". He suggests that the very nature of modern technology serves to separate us from truly engaging with the world, and with each other. Moreover, this happens without us being aware of it. This is modernity for us. I will paraphrase several of his examples to illustrate this point.

Prior to microwave ovens and supermarkets, cooking and shopping, in the domestic sense, was social in its nature. I acknowledge the sexist agenda in that women were the cooks and shoppers in this era. However, shopping involved visiting several shops including butchers, fishmongers, bakers, grocers and even haberdashers. (I recently lost a button from my well-worn jacket. I tried to find a shop that would sell me a replacement button and to this day, have not found one). In these shops the 'housewife' (sic,) could discuss new produce and seek advice on ways to prepare food. The shopkeepers knew her and she knew them. They were all active participants in a local community. Supermarkets rarely offer this sense of community, nor do their employees have the requisite expertise to offer guidance. They offer instead, efficiency. But, as Postman (1993) questions, from whose point of view is the efficiency warranted and what might be the costs? Food today is mass-produced and 'cooking friendly' in order to serve the perceived needs of a modern family lifestyle. Previously, the daughter would learn 'housekeeping' (sic) skills from the mother. Food would be prepared and as part of the process of eating, the family would sit together and interact with each other. I accept that whilst this is a somewhat romanticised view of family life prior to supermarkets and microwave ovens, it is not entirely misplaced. Borgmann (1984) does not argue that life was better before modern technologies and large-scale organisations. He argues that to in order to live in harmony with the world we must engage with it rather than withdrawing from it as a result of technology. He further argues that that engagement must not only be active, but in order to be fulfilling, democratic and sustainable, it must involve human effort, actual physical and cognitive engagement with the world. The combination of the supermarket and the microwave oven destroys communities, reduces food production to that of technological instrumentalism, isolates families from each other, reduces the act of dining to that of life sustaining fuel consumption and more sinisterly, as a result of 'efficiency' in food processing and aggressive marketing, takes the utility of food beyond mere eating to sustain life to a new level of addiction leading to obesity.

Ironically, as our technological lifeworld (Ihde 1990) 'progresses' in modernity, we regress towards instrumentality. The efficiencies promised by the supermarkets such as everything under one roof, or cost- saving resulting from bulk purchasing, or increased customer choice facilitated by offering a wide variety of goods is problematic. The means to accomplish these ends inevitably and inexorably results in the closing down of local high street shops, the control by corporate conglomerates over their junior suppliers (think about the destiny of UK farmers as one example) and the reduction in choice as produce is offered only if the supermarket considers it to be economically viable-thus limiting our choice to global market forces (My elusive buttons for example).

Ironically, while most of us buy into this (post)-modern lifestyle willingly, we are nevertheless constantly amazed at the disturbing rise in obesity, the evermore obvious effects of global warming etc. We seem to realise at some deeper level that shopping in the supermarket is actually as unfulfilling as eating the processed food they sell, but for some reason we do not seem to mind. Why is this? Technology was supposed to be utopian. We were all led to believe that technology would enable us to have more leisure time, to have a higher quality of work experience, to work in the paperless office! It was seen as something that would free us from all previous hardships and ills. Why is it then that the actual focus of technology seems to have focussed upon the production of consumer goods? (Power, 2000). We clearly do not have more leisure time. We seem to work longer hours in the UK than in any other country in Europe and the paperless office is a myth. As uncritical consumers occupying this technologically mediated world, we have become as processed as the supermarket food we eat. (Human beings in an airport illustrate this point).

Design and technology education cannot ignore this. We must guide children's learning towards developing a critical awareness of what it is to live in a technologically mediated world. I do not suggest that we inculcate children into developing a dystopian view of technology. Rather, I suggest that design and technology education (and other subject domains also) need to engage children in a discourse about technology. They need to see the benefits of technology as well as the potential dangers it can harbour. As we move into the twenty first century, our lives are being transformed at an alarming rate not only by new and emerging technologies but, significantly, by the subversion of those technologies, intended or otherwise, which serve to dramatically alter our lives. Thus technologies such as Information and Communications Technologies, the development of which was for the good of humanity, have enabled global networks of terrorists to engage in new and terrifying forms of warfare. The development of the automobile, the provider of mobility and freedom, but whose proliferation has resulted in the increase in greenhouse gasses, has contributed much to global warming. The potential that nanotechnologies, coupled with the merging of flesh and machines might offer, all serve to illustrate the absolute need for us all to engage in a new literacy, a literacy which will enable us to reflect upon our new technological lifeworld.

The post-modern world we now inhabit is heading toward a crisis of hegemonic apathy, or may indeed be already there. In western liberal democracies we have the means, mediated by constantly emerging technologies, to transform the world, both physically and culturally, to suit our subjective ends, but as Feenberg succinctly puts it: "we know how to get there but we do not know why we are going or even where" (Forthcoming). I would argue that design and technology education can and must enable children to engage in mapping out the why and where rather than being guided by the few who are technologically literate and use that literacy to form a techno-totalitarian consumer world order.

The critical understanding of technology, with which the education we need must be infused, is one that sees in it a growing capacity for intervention in the world, one that must necessarily be subjected to the political and ethical test...I mean here the ethic that is at the service of the people...not the narrow and mean ethic of profit and of the market. Paulo Freire (2004)

The need for developing Technological Literacy in the classroom

For Dewey, technology is central to humanity and girds human inquiry in its totality (Hickman 2001). "In his view, technology is evidenced in all manner of creative experience and problem-solving. Technology should, according to Dewey, extend beyond the sciences proper, as it encompasses not only the arts and humanities, but the professions and the practices of our everyday lives. In this account, technology is inherently political and historical and, in Dewey's philosophy, strongly tethered to notions of democracy and education which are considered technologies that intend social progress and greater freedom for the future" (Kahn and Kellner, forthcoming).

It is the central argument of this paper that in design and technology education, we do not sufficiently engender in young people an abiding curiosity about how the technologically mediated world, in which they live, actually affects them. I do not argue for major revisions to be promulgated in our curriculum structures. On the contrary, I argue that they already exist but are not exercised in the classroom.

A new rationale for technology education

If one reads the various rationales for design and technology education from across the developed world, it becomes clear that the formation of a technological literacy is a universal aim. Children are expected to develop informed attitudes about the potential and actual consequences various technologies will have upon the environment, both locally and globally.

A technologically 'literate' person is essentially, one who understands what technology is, how it is created, how societies shape it and how, in turn, it shapes societies.

The last twenty years has seen major curriculum reforms in technology education around the world. These reforms have redefined technology education into a more sophisticated subject area which has, at its heart, the distinctive characteristic of technological literacy. This generic area which is common to all developed countries offering technology education at school level, can be seen in the various rationales for the subject. For example:

- United States of America
  Students will develop an understanding of Technology and Society. This includes learning about the cultural, social, economic and political effects of technology, the effects of technology on the environment, the role of society in the development and use of technology and the influence of technology on history. (Standards for Technological Literacy. International Technology Education Association. Technology for all Americans Project. http://www.iteawww.org/TAA/PDFs/xstnd.pdf Accessed 01 May 2005. p15) (It is significant that this Document has been translated into Finnish and Chinese)
- Scotland
  Students should be able to appreciate that technological developments have consequences for people and the world in general, apply considered moral and ethical judgements in evaluating technologies and apply moral and ethical judgements to considering the effects that proposes solutions may have on the well being of individuals, societies and the local or global environment. (Technology Education in Scottish Schools: A Statement of Position from Scottish CCC. Scottish Consultative Council on the Curriculum. Dundee. p8)
- England
  Students will consider issues that affect their planning for example, the needs and values of a range of users; moral, economic, social, cultural and environmental considerations. (The National Curriculum Online: Design and Technology). http://www.nc.uk.net/webdav/servlet/XRM?Page/@id=6001&Session/@id=D_5tUMAqvYc22VM76mHQks&POS[@stateId_eq_main]/@id=3742 (Accessed 01 May 2005)
- New Zealand
  Students become aware of the diversity of valid ways in which different groups of people respond to technology and to innovation, and appreciate the impacts that technological changes have on different peoples. They develop understanding of the beliefs, values, and traditions of other people and how these influence technological development. They explore the impact of technology on the world around them and are able to take informed roles in debate on technological change. They can appraise the appropriateness of technological solutions to environmental problems. (Technology in the New Zealand Curriculum. p7). http://www.minedu.govt.nz/web/downloadable/dl3614_v1/tech-nzc.pdf Accessed 01 May 2005)

Clearly, these represent a common rationale for technological literacy that requires an understanding of the role of technology and its impact on society and the use of technology (frequently the integration of discrete technologies), to solve problems and meet human needs. These are seen to be important dimensions of learning in this domain. Technological literacy also calls for the development of informed attitudes and a capacity to understand and question the social and ethical implications of technological change.

Is technological literacy being developed in classroom practice?

My argument may be considered contentious here. I simply do not accept that technological literacy is being developed in classroom practice. I do not see technologically literate students engaging with the world as a result of their technological education. Consumerism is in the ascendancy, obesity is becoming a serious health issue and, as I have stated previously, hegemonic apathy is becoming the new world order. Moreover, since technological literacy is not formally assessed there is less impetus to teach it. It is also perceived as difficult to teach as it constitutes a major shift in pedagogy for teachers.

Further, the new rationales are not accompanied by the concomitant innovation in initial teacher training/education which is necessary to develop in teachers a deeper understanding of how to incorporate technological literacy into their teaching practice. In addition, the development of technological literacy in inset courses, together with the provision of resource materials1, does not sufficiently address this tension either. The development of teachers able to deliver courses which address issues relating to technological literacy must therefore become a major component in the construction of new courses.

The design and technology teacher must be able to act as a mediator, guiding the learning, intuition, imagination and creativity of the students through questioning, challenging, reflecting and suggesting, in what might be described as a dialectical approach to learning.

No one would argue against the notion that we, as a developed and humane society, are obliged to educate our children to be literate and numerate. I would further argue that in this new technological world, we are also obliged to educate our teachers and children to be technologically literate.

Given that technologies may range from the simplest of shelters to keep us warm and dry, to the most complex bioengineering interventions such as cloning, there is a growing need for human beings to be more critically involved in the discourse surrounding technological innovation. The real products of technology education are not the artefacts that young people produce, but rather the empowered young people themselves – people who are able to intervene in a creative, sensitive and informed way to improve the made world (Kimbell and Perry, 2001). We must as technology educators help children to understand about sustainable and ethical production, as well as being consumers, thereby helping them "to redesign and reconstruct modern technology towards making it more applicable to people's needs and not just their manufactured desires" (Kahn and Kellner, Forthcoming).

I think that this issue requires more deliberation, hence this paper. I conclude with this thought. If there is a general consensus that technological literacy must be an integral part of (design and) technology education, and I believe that there is a move towards this view, how do we go about it? If I want to change the look and character of my house I have several options. I can build an extension on to my house but it will always be an addition to my house, something extra, something added on so to speak. If on the other hand, I form an extra room in my loft space I am reconstituting existing space. I am changing the use from loft space to bedroom or study. But this will require sacrifice, I will need to construct a stair which will encroach on the floor below, I may need to throw out a lot of 'stuff' which occupies the loft at present, I need to make decisions about what to lose in order to change the function. I could simple decide to paint my house in order to make it look different. Whatever I choose to do in order to constitute a change; adding on, integrating into or changing the look by painting, the general foundations will nevertheless remain the same. I wonder if we need to build a new house for a new century?

Notes

See for example Primary school based INSET manual for design and technology (volumes one 1998, and volume two 1999) published by DATA. Design and technology: Primary lesson plans based upon the QCA schemes of work published by DATA . The QCA schemes of work, published by DfEE. The Nuffield primary solutions in design and technology, published by DATA and the Nuffield design and technology in the primary curriculum materials.

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Supporting Trainee Primary Teachers' Understanding of Teaching for Creativity

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Introduction

In contrast to the recent explosion of research literature, government directives and NGO reports related to creative learning and teaching in schools, the most striking aspect of the literature on creativity in teacher education is its sheer scarcity. The words 'creative' and 'creativity' hardly appear in the last ten years' volumes of the major teacher education journals, nor is there a single book title bringing the terms together in relation to primary education. In spite of the current vogue for creativity in official circles (DfES 2003, OfSTED 2003a) there has been scant attention paid to the needs of trainee teachers in preparing them to teach in an education system that has, on the one hand, reached new levels of prescription and control, while on the other, is calling into question the tight prescription of the last ten years and is beginning to promote a vision for schools that promote creative teaching and the creativity of the learner (NACCCE 1999, Howe et al 2001, Kimbell 2002, OfSTED 2003a). There are also claims that teacher training is one of the key factors inhibiting creativity in the workforce (NESTA 2002) and repeated recommendations that …

> "*...we should also encourage individual ITT institutions to develop initial training and CPD courses in creative teaching and learning.*" (Joubert in Craft et al 2002:.33)

The lack of attention to creativity in teacher education is not a recent phenomenon. Demetrulias (1989) noted a lack of congruency between the universally accepted belief that creativity is an important characteristic of a teacher and its lack of development and/or nurturing in teacher education programmes. OfSTED (2003b) in their review of quality and standards in primary initial teacher training, make no mention of creativity whatsoever. It might well be expected that:

> *"Prospective teachers who are trained in thinking and teaching creatively and in creative problem-solving will be better prepared to value and nurture the same creative characteristics in their classrooms."* (Abdallah 1996: 52)

What may also be required is a shift in attitudes towards creativity or self-belief as a creative individual on the part of trainees – an approach which has come to be known as a 'conceptual change' model of teacher education (Smith and Neale 1989). This is based on the premise that:

> *"Prospective teachers...bring their implicit institutional biographies – the cumulative experience of school lives – which, in turn inform their knowledge of ...curriculum."* Britzman (1986, p. 443)

This assertion finds support in much of the teacher education literature. John (1991) working with trainee teachers of mathematics, found that their experiences of the subject at school had a marked effect upon their attitudes towards it. This may lead them to regard certain subjects – such as mathematics – as devoid of creative potential, a hypothesis explored in the Bath Spa University College directed task below.

Bath Spa University College Directed Task

This preliminary study aimed to explore primary trainee's preconceptions of creativity within the subjects of the primary curriculum, and to challenge these notions through observations in school of actual lessons. The theoretical framework for this was adapted from Harrington's 'creative ecosystem' (1990), containing the following indicators of teaching for creativity:

- Opportunity for play and experimentation/exploration
- A non-threatening atmosphere in which children are secure enough to take risks and make mistakes
- Activities presented in exciting or unusual contexts
- Opportunity for generative thought, where ideas are greeted openly
- Opportunity for critical reflection in a supportive environment
- Children given a sense of engagement and ownership of ideas and tasks
- Respect for difference and the creativity of others
- Choices given to children in terms of resources and methods

Primary PGCE trainees, in the first few weeks of their course, were set a school-based directed task to:

1. Choose two lessons to observe. One should be in a subject area that you consider to be 'creative'. The other should be in an area that you think has less potential for creativity. Write a brief rationale for your choices.
2. As you observe each lesson, take note of any elements of a 'creative ecosystem' that exist in the classroom. Use the list above or other criteria of your own to help you make a judgement. Watch how the teacher introduces the activities, how she/he interacts with children and how the children respond. Talk to them about their work and take particular note of any children who are taking a novel approach to an activity or expressing interesting ideas.
3. Compare your notes from the two lessons. Which offered the greatest potential for creativity? Why? Did this confirm your hypothesis? How could the other lesson have been made more creative? What are the key factors in teaching for creativity in your view?" (PGCE primary course handbook 2003-4)

For a fuller account of the methodology, see Davies et al 2004. Findings revealed that Art & Design was far more likely to be chosen as the 'creative' subject to be observed than any other, with 39% of trainees selecting it, whilst the majority (73%) expected mathematics to offer very limited opportunities for children's creativity. However, once they had observed the lessons and analysed them against Harrington's framework, 36% of respondents were surprised by the creativity they observed in their 'non-creative' choice, with a further 21% having their expectations only partly confirmed. Only 9 respondents (7%) chose D&T as their 'creative' subject, but these observed D&T lessons offering more scope for generation of ideas, critical reflection and choice of materials and methods than the curriculum as a whole, though critical reflection was generally observed as weak. In no area of the 'creative ecosystem' did D&T appear to perform significantly less well than other subjects. In summary, trainees appear to have begun their course with preconceptions about creativity in the primary curriculum and the task we have asked them to do has begun to challenge those preconceptions.

'Draw a Creative Person' and Questionnaire at MMU and Goldsmiths

This early aspect of the research project set out to explore how trainees at Manchester Metropolitan University Institute of Education and Goldsmiths', University of London, perceived particular aspects of creativity within individuals. These were explored through drawing a cartoon of a 'creative person', a tool used by Chambers (1983) and others to investigate stereotypical images of scientists. For a full account of the methodology used see Davies *et al* (2004).

At MMU, picture annotations included tools and equipment, which provided the evidence for the 'reference to' categories (art, product design/D&T and science) (figure 1). Occasionally these

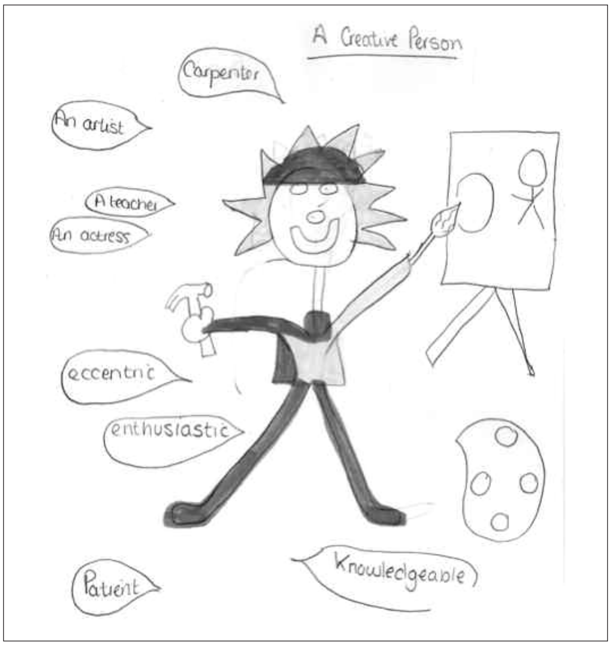

Figure 1: Drawing of a 'Creative Person' from Manchester Metropolitan University

appeared in thought 'bubbles', but the most common illustration in a thought bubble was either a light bulb or a question mark. There was also only one reference to a creative teacher and one reference to a scientist. Overwhelmingly, it was art (46%) which was seen as the occupation of a creative person, with a small number of references to product design (11%), usually in the form of a few random woodworking tools, rather than a product outcome. Even though the trainees were being asked to draw the cartoon in a D&T session, still only 15% made any reference to D&T or product design.

Unlike the trainees at MMU, there were more references at Goldsmiths' to product design/ D&T overall (43%) than Art (30%) with proportional evidence of product design output (26%) to artistic outputs (8.7%). There were no references to science. The focus overall appears narrower in the Goldsmiths' cartoons (even taking into account the smaller sample) with only one reference to other careers – a female fire-fighter who had visited the trainee's placement school.

Trainees at both institutions were also asked to complete a questionnaire about their perceptions of creativity. When asked to define the term 35% of the first year trainees identified imagination and having ideas as elements of 'creativity'. The third year trainees perceived imagination and ideas as being of even greater importance, with 49% including these elements. Within the first year trainee group 'expression' attracted 21% responses while the third year trainees saw expression as being of great importance, with 45.5 % of responses using this term. For example, "Creativity is the ability to express and describe emotions and ideas." 39% of the first year trainees linked creativity with making something. A similar percentage of third year trainees, 42%, also defined creativity in this way. Interestingly amongst the first year group of trainees, 21% saw creativity as an individual attribute as exemplified by this response, "Creativity is an individual skill – there is no real definition" and for the third year trainees individuality, in terms of particular skills and talents belonging to an individual was also highly rated, with 25% of respondents mentioning it, for example, "Creativity is producing something without influence."

Only 8% of the first year trainees considered themselves being creative when at school themselves with even less at only 7% of the third year trainees. However, 36% of the first year trainees reported that they had been creative during their school experience placements and a similar percentage of the third years. In response to the question, "Can creativity be taught?" most of the trainees agreed that creativity can be 'shaped', 'encouraged' and comes from 'inspiration'. Many commented on the necessity of an individual's 'natural flare' as the basis for creativity and the need for children to have the opportunity to explore and extend their existing talents. Both groups of trainees gave very clear indications on how the school environment could encourage creativity with displays featuring very strongly. Some responses moved away from the visual environment to consider the atmosphere of the classroom, for example, "encourage children to share ideas, brainstorm how things can be done differently. Have an inviting atmosphere". Another trainee suggested that this could be achieved "by encouraging children to express their creative ideas and for teachers to scaffold them" while another simply responded by writing "celebrating it". Freedom to explore and thinking and development time were considered of utmost importance amongst the third year trainees, whilst the influence of teachers and the need for a positive attitude together with the giving of confidence were consistent themes. However two respondents commented on the effect of 'curriculum overload' on creativity and most worryingly of all; "it is very hard, we are taught to conform which is anti-creative."

The 'Creative' Primary School CD-ROM and virtual learning environment

In order to provide trainees with opportunities to observe and analyse episodes of teaching for creativity across different primary subject areas, the second phase of the *Creative Teachers for Creative Learners* Project has involved the collection of case study material from ten primary schools in London, the North West and South West. We have used digital video as a means of capturing classroom episodes which we judge to exemplify aspects of Harrington's ecosystem, together with supporting planning and other documentation. All video material has been scrutinised by a team of five researchers representing the three institutions involved, to agree upon common interpretations of ecosystem elements and select short clips for inclusion in a CD-ROM containing a Microsoft PowerPoint presentation of a virtual 'creative primary school'. Video clips of teachers working with different age groups in different subject areas are embedded in pages containing contextual information and questions for trainees to consider. There are also clips of subject leaders and head teachers describing their approach to promoting teaching for creativity. Hyperlinks enable users to navigate between pages by using a 'map' of the school, a list of subject areas and age groups, or a grid identifying elements of Harrington's creative ecosystem linked to specific classroom episodes. The CD-ROM has been piloted in 2004-5 with a sample of trainees in each project institution, during which Bath Spa trainees have been invited to post their responses to six key questions and engage in discussion via 'Minerva', a web-based virtual learning environment using the Blackboard platform.

Piloting the 'Creative' Primary School CD-ROM and VLE at Bath Spa

In October 2004, volunteer PGCE trainees were recruited to pilot the resource (n = 42). They were randomly assigned to two groups: the Autumn group would have access to the CD-ROM and invited to contribute to the VLE discussion board from October to December 2004 and the Spring group would be given the resource in February 2005 (following a block school experience). Both groups were invited to complete web-based questionnaires in October and February in order to gauge impact on perceptions of personal and school-based creativity with and without the resource. The 'Spring' group were again invited to complete the questionnaire 'post-treatment' in April 2005. At the time of writing, the data from these questionnaires has not yet been fully analysed, though the 'Autumn group' contributions to the discussion board indicate considerable engagement with the issues. For example, in response to a video clip of a Y5 child describing the choices of materials and techniques she had made during a D&T design and make assignment on 'shelters' (figure 2), one trainee commented:

> *"From watching the pupil discuss the various options her group could have selected from I think there has been a lot of class and group discussion prior to them making their decision. Probably some lead from the teacher, reminding the class that there is no one, right way to build a shelter. Building up the topic with lots of research activities could have helped the pupil's confidence. For example looking at different shelters around the world – Bedouin tents, Indian TeePees, Thai grass huts."* (trainee 1)

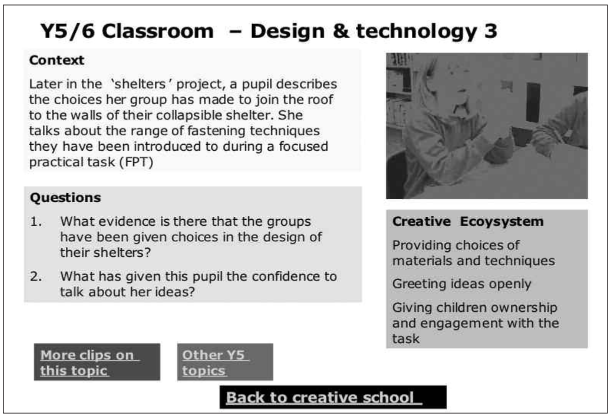

Figure 2: Slide from 'Creative Primary School' CD-ROM

Another trainee picked up the issue of 'social creativity' from the same clip, which led to a discussion between several trainees and two tutors:

> *"I noticed that she used 'we' when talking about the design options rather than 'I'. In the first clip the teacher stressed the collaborative nature of the exercise. He said the groups should arrange their tables in a way they 'find most useful'. He then stressed twice that the 'group' should decide how to rank the specifications."* (trainee 2)

> *"Creativity as coming from a group rather than an individual is new to me and contrary to my own educational experience. What does anyone think? How does collaborative work compare to individual work in the 'creative ecosystem'?"* (trainee 3)

Although the pilot is still ongoing and results have yet to come in from the 'Spring' group, it appears that, in the above cases at least, the virtual *'Creative Primary School'* resource is stimulating thought about teaching for creativity amongst trainees.

Summary and conclusions

Although the methodologies were completely different in the Bath Spa and Goldsmiths/MMU studies, certain common messages emerge. Of most significance is probably the emphasis on fine art as being the 'natural home of creativity' (selected by 39% of Bath Spa trainees, 46% of MMU trainees and 30% of the Goldsmiths' sample. Few Bath Spa or MMU trainees made any reference to designing and making using materials, indicating a disregard for D&T as a creative subject or designing as a creative profession. However, 43% of the smaller sample at Goldsmiths' made reference to product design or D&T, perhaps reflecting the higher status both enjoy at this institution.

Whilst most trainees in each institution reported having observed some 'creative' practice in primary classrooms, the above findings raise the concern that primary trainee teachers at the beginning of their programme tend to have a rather narrow, arts-based view of creativity in the primary curriculum, but that this can be challenged by access to focussed observation of classroom practice using a framework such as Harrington's 'creative ecosystem' (1990). The emerging evidence from the pilot suggests that the development of tools such as the virtual 'Creative Primary School' offers ways forward for training providers to challenge trainee's initial perceptions of creativity in the primary curriculum and begin to develop an understanding of some of the elements of teaching for creativity.

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'Creative Friends' in a Collaborative Project: Playing with Sounds

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Abstract

Typically, children's design projects are planned with outcomes for a single age-group in mind. Learning outcomes are identified in advance, and this has become an orthodoxy in the UK, reinforced by the expectations of the inspectoral regime which few teachers feel able to challenge.

Recent initiatives suggest that more powerful learning may be achieved by working with children's ideas in ways that respect the creative imaginations of childhood (DfES 2003). Children in the later years are sometimes set tasks that involve designing for younger children, but rarely work with younger children on collaborative ventures. The project reported here takes the form of a collaborative enterprise between children in the Reception class and pupils from the top of Key Stage 2, to realise the younger children's design ideas, with the older children acting as 'creative friends' (Best & Craft: 2004). The project uses techniques based on an understanding of the Reggio Emilia project-based approach (Edwards, Gandini & Forman: 1993; Forman: 1996; Abbott & Nutbrown: 2001) which, rather than planning outcomes in detail in advance, seeks to 'make learning visible' when projects stem from children's ideas. Reflections by children from both year groups on their personal learning through the project form the data set from which some conclusions about D&T activity can be drawn.

Introduction

Typically, children's design projects are planned with outcomes for a single age-group in mind. Learning outcomes are identified in advance, and the expectation is that these will be fulfilled in specified lessons. This has become an orthodoxy in the UK, reinforced by the expectations of the inspectoral regime which few teachers feel able to challenge.

Recent initiatives suggest that more powerful learning may be achieved by working with children's ideas in ways that respect the creative imaginations of childhood (NACCCE: 1999; DfES: 2003). Awareness has grown in educational and governmental circles that the strictly bounded and prescribed curriculum defined in the late 1980s, heavily content-driven, and the strong focus on literacy and numeracy of the late 1990s had squeezed the more open-ended educational approaches that encourage thinking skills, problem-setting and solving. Concern has been expressed that creative approaches to teaching and learning had been abandoned. Among the conditions for creativity to occur in learning are a degree of open-endedness, tolerance of reflective and iterative thinking, and of uncertainty of end-points, a valuing of outcomes whether or not they are pre-specified, and a respect for the ideas and expressions of the learner. A further condition is that the teacher should be 'in touch' with her/his own creativity, and should aim to teach creatively. 'Creative teachers provide vivid and motivational educational experiences of the highest order' (Howe, Davies & Ritchie: 2001:30). The NACCCE report also recognised that 'teaching for creativity involves teaching creatively. Young people's creative abilities are most likely to be developed in an atmosphere in which the teacher's creative abilities are properly engaged' (NACCCE: 1999: p90).

Much attention has been paid in the last decade to the philosophy and practice in the nursery schools of Reggio Emilia. Here, planning starts from the concerns of children, and the pedagogy combines the use of 'provocations' (introducing to the setting items that are expected to stimulate the children's imaginations), detailed planning of the ways in which children will be encouraged to reflect upon and develop their ideas, support for the projects that children want to carry out, and meticulous chronicling of the children's 'learning journeys' through their individual and group projects (Edwards, Gandini & Forman: 1993). One of the keys to the success of this approach is the employment of an *atelierista* in each setting. This role is given to an experienced artist, but is rather different from that of an artist-in-residence, in that the *atelierista* is there specifically to support children in developing the materials-handling skills they need in order to realise their ideas. The studios are key working spaces for the children – the 'philosophical hub' of the schools. (Bishop: 2001: 76). Like much of the practice of the Reggio nurseries, it is unlikely that the use of artists as a regular feature of life in English primary schools will become widespread, for both historical and cultural reasons. Nonetheless, as an approach, facilitating the development and realisation of children's own ideas has much to recommend it in design and technology practice, and is worthy of consideration. Another way of using expertise is the 'creative friend' approach adopted in some creative partnership areas and analysed by Best & Craft (2004). In the schemes that they evaluated they report on a range of approaches in which 'creative friends' acted as brokers mediating experiences for secondary school children with work settings in the creative industries. They found a range of levels of engagement by the 'creative friends', from closely hands-on with teachers and students, to taking more distanced positioning. Again, it is harder to envisage a model that would be effective for primary schools, partly because younger children are more distant in the life-course from the world of adult work, and also because what may be cost-effective across a small number of large secondary schools is unlikely to be so with schools that are very much smaller. Schools in the primary sector, however, do have an abundant resource of 'more expert others' in their older pupils.

Children in the later years of primary school are sometimes set tasks that involve designing for younger children, in which the young child is given the role of client, but rarely work with younger children on collaborative ventures. NACCCE (1999) point out that creativity 'can be expressed in collaborative as well as individual activities' (p28).

The small project reported here takes the form of a collaborative enterprise between children in the Reception class and pupils from the top of Key Stage 2, to realise the younger children's design ideas, with the older children acting as 'creative friends' in the closer involvement position (Best & Craft: 2004). The project used approaches to learning based on an understanding of the Reggio Emilia project-based approach (Edwards, Gandini & Forman: 1993; Abbott & Nutbrown: 2001) which, rather than planning outcomes in detail in advance, sought to 'make learning visible' when projects stem from children's ideas. Reflections by children from both year groups on their personal learning through the project form a powerful data set from which some conclusions about D&T activity can be drawn.[1]

'Creativity is itself a mode for learning (which) involves a thoughtful playfulness – learning through experimental 'play'. It is serious play conjuring up, exploring and developing possibilities and then critically evaluating and testing them' (NACCCE 1999: 92). In the project, the intention was to liberate children's creativity by engaging them in playful activity while enabling them to create their products through a series of design decisions, in which they would be supported and guided.

The context

The school is a moderate-sized primary school in a large village in Hampshire. A concern for the staff has been to encourage children to use their senses more actively and more variously in exploring their world, and together staff and children are working on ways to increase the sensory stimulation afforded by the outdoor environment. The early years teacher has been working alongside the science coordinator and teachers in a nearby school in a collaborative funded project, supported by a team from University College Winchester, to research and evaluate strategies for increasing children's willingness to use a variety of senses in exploration. As part of this initiative, I volunteered to work with children in Year R (aged 4-5 years) on a short design-and-make project exploring sounds. Prior to the project days, the teachers and I met and discussed some parameters. In particular, since the products of the project would be used in the outdoor area, we decided in advance that the focus would be on using natural materials. The parents of the children were informed of the project, and asked to contribute materials. We also decided that the children would work in pairs, and that each pair would be supported by a 'creative friend' from Year 5 (aged 9-10 years). The Year 5 children were invited to volunteer for this activity.

The school has recently had a new communal work room constructed, and this was allocated to me for the two days of the project. Children came to work with me two pairs at a time, with their 'creative friends'.

The project

Children were given the brief orally. The task was to make something which would make a pleasant noise in the outdoor environment. Materials were available that would have supported a range of different possibilities, including shakers. (However, in previous discussion with the children, the teacher had used the term 'wind chimes', and children's thinking had clearly been influenced by that). These materials included stones with holes through them, shells, some exotic seed pods, lengths of bamboo and rattan cane in different sizes, ivy stems, some wooden rings for curtain poles, tree cones, gourds and smooth gravel. Different thicknesses of string were also offered, from garden twine to linen thread. The first part of the task was to explore the materials, to test the sounds they made when knocked together, and to choose a set of four or five objects which would make pleasant sounds.

Figure 1: Choosing material

Children were then asked to consider how these would be brought together in an artefact by laying their materials out on a table in the configuration that they wanted. This enabled them to identify what would be needed in order to develop their artefact. The modelling phase of designing was thus in two parts: the aural work analysing different sounds and choosing between them, and the visual-spatial work of considering layouts in space. 'Creative friends' helped with the decision making, and assisted with skills such as drilling, threading strings through holes and tying knots. As each group completed their project (which took approximately 1 hour or less) we talked briefly about what they had learned. At the end of the whole intervention, I conducted a short group interview with the 'creative friends'.

Outcomes

Every child in Year R participated, and successfully made a 'noise maker'. Only two children were unable to collaborate with each other and made individual products. The 'creative friends' clearly helped with the decision making, and supported the Year R children in staying focused on the project. It became apparent, however, that they were less able to support the younger children in their skills development, because they themselves were less experienced in the use of tools and materials than I had anticipated. They were attentive however, as I introduced each group to the processes of drilling holes, threading and tying knots; and quickly developed their own skills through supporting the younger children.

Figure 2: cooperative drilling

All the outcomes were quite distinctive: although children in the later groups had the opportunity to see earlier products, they seemed to be basing their ideas wholly on their own explorations of the materials.

Figures 3 and 4: products completed

What did the Year R children think they had learned? A sample of typical responses is given below:

- I: *What have you learned today?*
  Child A: We learned about working together to get things done
  Child B: hanging up
  I: hanging up?
  Child B: tying up
  I: *You learned how to tie the things up so they would hang and swing?*
  Child B: yes… how to make a noise maker…
  I: *And what else were you learning about*
  Child C: drilling
  Child D: wind chimes
  I: *you made wind chimes. Are you pleased with your wind chimes?*
  Child D. we learned how to make them
  Child E: I learned… it's easier to work together… and help each other
  Child F: I didn't know that you could use one of those things (the drill)

The majority of responses from the Year R children focused on the more obvious physical skills of drilling, threading, and tying knots, although much decision making may be subsumed under the response 'We learned how to make them'. It is interesting, however, that one or two children focused their responses on the benefits of collaboration. I am unclear as to the extent of children's prior experiences of collaborative work in the school context, so it is difficult to comment on this in detail.

Children were immensely pleased with their products, and several weeks later the teacher commented to me that they were still enjoying playing with them and listening to the variety of sounds that they were able to create.

The Year 5 children were asked to comment on the process of supporting the younger children. Most of the early responses focused on the social benefit of getting to know (and be known by) the younger children:

- I: *How did you find working with the Year R children?*
  Child 1: It's fun
  I: *fun?*
  Child 1: Yes, and it is helpful to get to know the Year R
  I: *So that's useful?*
  Child 1: Yes, because when we're Year 6, and they are Year 1 or 2, and if they're upset, you can go up to them and say 'are you all right?'

They recalled their own early experiences of feeling nervous about older children:

- Child 2: I think it's good to get to know Year R as well,

because sometimes when you first start in Year R, you're a bit frightened of the older ones, well you're not too keen, you're not quite sure what they're like.. but then
I: *they might think you're scary?*
Child 2: Yes, a bit (laughter); but when you come to help – when we came to make the windchimes with them, they get to know you, and…
Child 3: When you like do this, at first the Year Rs they stay away from you and don't go near you; then when they get to know you it's better, because they'll stay near you and this helps us know them more.

They recognised the usefulness of the support that they gave:

- Child 5: I liked working with the little ones. It think it was like, helping build their confidence up; because when I was helping xxx, at first he was scared about doing the drilling, but then he liked it when he actually did it.
  Child 6: I think it was quite a good experience, working with the little ones, helping them learn, because then the things; before they made the windchimes they might not have known how to tie a knot, or things like that; and we actually helped them learn.

They were also able to articulate their own learning well. Again this mainly focused on skills learning, although not exclusively:

- Child 7: I learned how to make all sorts of noises with different materials; and we learnt how to thread better – putting the string through the holes
  Child 9: and we had to help them – we learned how to tie different knots and things
  Child 5: and I didn't know that a shell could crack in, like, 1 millisecond
  Child 8: I learned how to tie a knot better *(laughter)* I already knew that, but mine kept coming undone
  Child 4: and they quite liked, you know, doing the drilling.

Some of this may have been reinforcement learning – revisiting skills in order to be able to scaffold the learning of a less expert child. Certainly, as I observed the older children working with the younger ones they were taking much pleasure in the task as well as in supporting the Year R children.

They also saw benefit to the social learning provided by the experience:

- Child 10: and it helped…. Yeah, it helped everybody to share and work together
  Child 8: it actually helped Year Rs and us to learn how to cooperate more in a team.

Conclusions

The benefits of working with 'creative friends' were not as strong as I had hoped at the outset of the project, because the older children had clearly not had the breadth of prior experience that I had anticipated. This reflects the reduction in time and resources allocated to foundation subjects generally in the primary curriculum, and particularly to those like Design & Technology which are resource-intensive. If such partnerships between children in older and younger age groups are to be of maximum benefit, then it is desirable that the older children are able to draw upon a more extensive knowledge base about such aspects as materials handling. Whereas I had expected that the 'creative friends' would take on the role of *atelieriste* in the project, the reality seemed to be that they became learning helpers, whereas I myself moved in as *atelierista.* This work does, however show that such collaboration both helps to scaffold the learning of the younger children, and supports the older children in developing and revisiting practical skills.

Creativity is hard to define, and harder to assess (Beetlestone: 1998: 7; Craft: 2002: 163). Indeed, one might question whether it is desirable to attempt to assess creativity in conventional terms. So to what extent did this work support the young children's creativity? It is certainly the case that they needed encouragement at the outset to explore the materials. This could be due to a learned passivity in school; but it could also be uncertainty about the learning space (usually given over to activities for the older children, since it is physically distant from the Year R classroom) or about working with an unfamiliar adult. During their work, they moved from uncertainty and nervousness (for example about using the drill) to positions of confidence, in which at least one child would have happily spent the whole time using the tools with no regard for moving toward a product! One could assert that this confidence in using materials is at least an outcome of creativity.

Children were also using their creative imaginations in moving from testing the various components one against another and listening to the sounds they made, to thinking about what it would be like if several of these sounds happened simultaneously, although this was not strongly articulated in the activity. They were using visual aesthetics too, in consideration of the way they would arrange their components spatially. Some were strongly influenced by the visual features of their chosen components, arranging them symmetrically, for example. It is not possible to claim more than this from such a small project.

It is clear that working with emergent objectives in this way does not prevent children from being aware of their own learning and able to reflect upon it. Levels of meta-cognitive reflection were high in the Year 5 group, but also evident in the Year R children. Creativity in teaching is likely to be based on emergent rather than specific objectives, and this is an approach that could be welcomed and fostered by the Design & Technology teaching community.

Notes

[1] Parental consent was sought for interviews with the children following their design-and-make sessions, and for photographic material to be gathered fro research purposes. No interviews were conducted or photographs taken unless parental consent had been obtained.

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Teacher Change in Response to Student Learning in Technology

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Abstract

Making judgments about student learning during ongoing technological activity in primary school classrooms has proven to be a difficult task for teachers. Hence, it is essential that teachers understand clearly the nature of learning that occurs as students engage in technology activity so that teachers can devise effective assessment processes thus ensuring high quality learning outcomes for students. Using an interpretive research methodology, the researchers investigated teachers' implementation of technology units of work in three different classroom and school contexts. Data sources included interviews, classroom observations, field notes, and analysis of artefacts such as written teaching plans. The findings indicate that changes were evident in teachers' pedagogical approaches as they became more cognisant of student learning. The implications of these findings for the professional development of teachers are analysed and reported in the paper.

Introduction

In order to determine the nature of learning that occurs as students engage in technology activity, teachers must acquire an understanding of essential features of technology, such as design processes and knowledge of relevant technology content. Design processes may be seen as the defining feature of the subject, indeed, some authors (Pendergast, 1998) have placed the process component, with design as a key element, at the core of any technology curriculum. Others (e.g., Eggleston, 1994) suggest that design is at the centre of technology. The notion of a technology knowledge base for teachers as being pivotal for effective teaching and assessment in technology has been advocated by Jones, Moreland and Chambers (2001). Davis, Ginns, and McRobbie (2002) similarly contend that because material properties (e.g., strength), and stability and bracing are important in many technological settings and activities, an understanding of these concepts should be part of an identifiable knowledge base for teachers in primary schools.

Assessment and making judgments about student learning in technology are recognised as complex and difficult tasks for teachers. For example, McCormick, Murphy, and Hennessy (1994), when discussing problem solving in technology, asserted that the observer has great difficulty in identifying the specific processes that are occurring as students engage in technological activity. Furthermore, the technology artefact in isolation is difficult to critique and may lead to an inappropriate emphasis on end products. Primary school teachers limited understanding of technology concepts and processes identified by several researchers (e.g Parkinson, 2001) may add to the difficulties experienced by teachers when making judgments about student learning.

The studies from which this paper was derived were conducted in a climate where a new Technology Years 1 to 10 syllabus (QSA, 2003) was being gradually introduced into primary schools in Queensland. Not only were teachers likely to experience the difficulties described above in assessing and judging student learning, they were grappling with implementing the syllabus and extensive supporting documentation and, for many, an unfamiliar subject area. The paper describes issues and difficulties that confronted three teachers as they implemented a technology unit of work for the first time and how they adjusted their teaching approaches as they became cognisant of student learning.

Methods and techniques

This paper reports findings from three separate research studies. Each study used an interpretive research methodology (Erickson, 1998) so that the meanings and purposes participants attached to their activities could be understood.

The participants were three primary school teachers, one each from three different schools in Queensland. The researchers investigated for approximately eight weeks each teacher's implementation of a technology unit of work in the respective classroom and school context. Brief details for each teacher follow: Laine was an experienced teacher of a Grade 4/6 composite class in a medium sized school in a country town (population 13000) (Study A); Jill was an experienced Grade 7 teacher in a large school in Brisbane (Study B); Arthur, in his second year of teaching, taught a Grade 5/6 composite class in a school located in a small country town (population 800) (Study C).

Laine's unit focused on natural disasters; for example, an examination of the ways, or systems whereby, toxic agents could be spread through a town, the development of a disaster management plan for rapid response to such an event, and the construction of vehicles that could be used in this type of emergency. The technology unit implemented in Jill's classroom involved the design and construction of 'simple and powered mechanisms' using Lego construction kits (Lego Educational Division, 2003), and concurrent exploration of key mathematics and science concepts (e.g., ratio; proportion; forces; energy changes) embodied in the activities. One of the researchers (SJN) planned and implemented the unit in close liaison with Jill. Arthur's first attempt at implementing a technology unit involved students in the design and construction of bird accommodation for the school. Daniel, the secondary school technology teacher, assisted Arthur during the preliminary materials selection and subsequent construction of the artefacts.

Data sources for each study included interviews, classroom observations, field notes, and analysis of artefacts such as written teaching plans. Interviews and classroom observations were video- and audiotaped. These data were analysed for instances where changes in teachers' pedagogical approaches were evident as they recognised that student learning was occurring. The findings are presented as brief vignettes, one for each teacher, that focus on the change noted and the student learning that may have initiated that change.

Findings

Laine (Study A)

In recognition of the outcomes based nature of the new Technology syllabus, it was evident in Laine's initial planning document that assessment would be a key component in the implementation of her technology unit. It was Laine's intention to focus on the collection and assessment of the end products of technological activity. As the unit progressed Laine realised that student learning was occurring, for example, as they developed the disaster management plan and, therefore, a fair, ongoing assessment of what students were undertaking at any time was now essential. This developing understanding of technology practice altered Laine's views of two issues central to assessment in technology.

The first issue encountered by Laine was how to accommodate ongoing assessment of the construction of artefacts into any assessment scheme, thus avoiding the need to make judgments based solely on selected qualities of the end product? Laine considered that such assessment might include making judgments about the intellectual processes students underwent in making artefacts, adding "The only way you could assess it (an artefact) was the children's understanding of what they had made, and what they had learned about their particular thing." Interestingly, students in Laine's class expressed similar ideas, for example, Kristal (Grade 6) stated, "You can't just go on speed (of the vehicle)…so you just really have to look at how well they've done and thought about it."

The second issue encountered by Laine was how to cater for a desire expressed by students to be given credit for their individual contributions to each activity, a problem made more difficult because Laine adopted a group work strategy for teaching the unit. Laine reflected on how she could do this during vehicle construction as follows, "What was important for me was the children's understanding of what was happening…(and)…had they come to some sort of understanding about what makes things move?" When asked if she could have given individual students a mark, she continued, "No, all I could have done is write an anecdotal note about that child's understanding of the way something moved."

Laine's emerging understandings of the complexity of assessment led to changes in the way she implemented the teaching unit. For example, the difficulty in enacting what she originally envisaged were appropriate assessment procedures resulted in the abandonment of any summative assessment, and neither marks nor comments of any kind were assigned to the students' efforts. Finally, daunted by the problems associated with the two key issues described above, her teaching approach changed radically such that the activities became "Just a chance for every kid to do something."

Jill (Study B)

Jill was a participant observer as the researcher (SJN) taught the two hour lesson each week which comprised the unit. Jill, originally, had expressed a lack of confidence in teaching the unit, hence, this vignette describes Jill's reflections on how to teach the unit as it proceeded.

Initially, the students' construction of various mechanisms (e.g., bridges; levers) from Lego plans was followed by attempts to engage them in discussions about the constructions at the end of each lesson. This approach was designed to help the students establish links between the constructed artefacts and the mathematical and scientific principles underpinning their construction and operation. However, many students did not appear to be able to articulate such connections causing Jill to suggest that in a complex unit where technology, mathematics and science were being integrated, even greater attention to the specific details of planning was needed, for example, "Do I want every kid to understand? What level do they need to understand at? You need to treat each kid differently and teach them at the level they are at now."

Further, Jill noted, "This group needs to have more structure because somewhere along the line they have missed out on the structural approaches, including those related to fractions." A strategy that took into account different levels of student readiness was developed jointly to attend to this concern – focus on written board work involving 10 minutes discussion and 15 minutes to write the ideas down, and return to building relevant artefacts. Subsequently, this strategy was used to identify the mathematics and science concepts associated with, for example, students' construction of tractors. The first part of the lesson was used to engage the students in an examination of gear ratio (board work) then, they proceeded to build tractors taking account of this mathematical concept.

Noting differences in student learning and motivation, Jill observed that a combination of lack of familiarity with the construction material and a lack of background in the underlying concepts caused disinterest in the tasks. She reflected, "I would like to see that it (Lego construction) would be implemented into a younger level so that when they get to this level they would know how to build. Same with the concepts, like they could say, 'Oh, yes that is just velocity.'"

Arthur (Study C)

The design and construction of bird accommodation for the school was Arthur's first attempt at using a problem solving approach in any subject that he had taught. Arthur resorted to a design challenge, a way of stimulating students' thinking he had discovered in staff professional development activities he had attended. Also, based on the advice of a colleague teacher, he presented the students with a contextualized problem to solve. The students' active involvement in the design challenge embodying the contextualized problem convinced Arthur that these techniques were worthwhile additions to his teaching repertoire, "The kids just rattled off twenty to twenty-five odd things that they will have to learn in order to solve the problem, and it was spot on, exactly what we had planned for. It was good."

Arthur noted another subtle change in his practice when he expressed the belief that he was no longer directly teaching a large amount of content any more. He remarked:

> *"It hit me today. I don't find myself teaching these children a lot of content. I think they find it out for themselves. You do not write it on the board and get them to copy it down. They have a lot more ownership of their learning. You have to really lay your trust in the kids, and it seems to be working."*

A professional development workshop that included an examination of ways to conduct controlled testing of the properties of various materials (e.g., controlled addition of weights to various fibres until breaking point) also impacted on Arthur's practice. Arthur capitalised on the usefulness of considering relevant material properties in the major design task. Working with Daniel, who possessed expertise in the properties of materials, Arthur encouraged his students to test the suitability of a variety of timbers from which the bird accommodation could be constructed. He observed:

> *"The children looked at the properties of strength, flexibility, and durability (of the timbers). Some children even boiled theirs in hot water to simulate (weathering) further."*

These exemplars of classroom and interview evidence support Arthur's own conclusion that his classroom practice had changed and he was "Really trying something different that I've never tried before. It seems to be working."

Discussion and conclusions

Laine' ideas of assessment changed to accommodate her new understandings of technology and students' learning. The two issues Laine grappled with were not necessarily complementary, on one hand insistence on a broader approach to student assessment, on the other hand catering for assessment of individual inputs into technological design and production. An implication of this vignette is the necessity to clarify the role of assessment in technology, otherwise teacher change in practice may so radical that they consider assessment too difficult, and view technology as just an opportunity for students "to do something."

Jill's reflections on student learning help us to understand the thoughts of an experienced classroom teacher who participated in a unit that provided an authentic context for the study of relevant scientific and mathematical concepts. In essence, her response to the teaching of technology was to suggest an increase in the level of scaffolding provided to make the learning outcomes more explicit, and change in the nature of scaffolding to provide, in particular, more explicit linking of the underpinning theory (science and mathematics) with the construction tasks. The findings in this vignette imply that teachers may require very specific assistance with developing and implementing pedagogical approaches that ensure the learning outcomes for all subject areas comprising an integrated unit are effectively taught and assessed.

Arthur's changes in teaching practice were facilitated through the input of colleagues and in-service activities. Arthur valued the constructive manner in which his teaching was supported both from within and from outside the school, and his own observations of the effects of his changed teaching approaches on his students and their attitudes reinforced his belief that the changes were beneficial. The key feature evident in this vignette is that effective support and successful teaching experiences may influence positively changes in teachers' practice as they grapple with the teaching of technology.

The three vignettes describe a range of issues facing practicing teachers, and indicate areas that could to be addressed through professional development activities. Important areas for consideration in this regard are the development of:

1 Assessment protocols that account for artefacts in an appropriate manner;
2 Pedagogical approaches that are essential for the effective teaching of technology; and
3 Environments within schools that are supportive of change.

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Necessity is the Mother of Invention: The Unforeseen Benefits of Large Class Sizes, Limited Resources and Teachers with Insecure Knowledge Surety

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Abstract

This paper focuses on Technology Education projects on vehicles by third year pupils (aged 8 years) in England and South Africa where the broad understanding of Technology Education is shared. One might therefore have expected similar experiences and outcomes. However in reality the pupil experiences were quite different as were the ranges of pupils' cognitive developments.

I will show the differences (and similarities) in pupil experiences, attempt to explain the reasons for these and the consequences.

Introduction

One of my research questions from a wider study of year/grade 3 pupils in South Africa and England was, "What are the similarities and differences in the children's experience of wheels and axles as a result of the teaching and learning?" In examining the data acquired for answering this question, I noticed dramatic differences in the way projects were carried out and pupils' learning developed. In this paper I have used the examples of two schools to highlight these. Both schools were mixed, had relatively high numbers on roll and were in urban localities. The primary data collected was in the form of observation notes, photographic evidence of the pupils' work, informal pupil and semi-structured teacher and headteacher interviews.

The Cape Town School

In Cape Town, the teacher started the project by telling the pupils to research wheels and axles as homework. The children then showed what they had found to the rest of the class. Pupils' contributions ranged in breadth and depth and included,

- Examples of toy cars, some were mass-produced, others were hand-made from reclaimed materials and some were made from construction kits
- Documents downloaded from the Internet
- Books
- Pupils' pictures and magazine cuttings.

This shared evaluation of research enabled discussion on the purposes of the vehicles and an explanation of the mechanisms to allow rotation or steering. The concepts and knowledge elicited was entirely from the pupils, facilitated by careful teacher questioning.

In the final stage of this lesson the teacher gave the pupils the very open-ended "design and make" brief, to find a need that interested them, and to produce an appropriate moving vehicle. They were to start this work at home over the weekend and bring in their work the following week.

The teacher used the homework strategy as it encouraged parental participation. Additional reasons for this: -

- The large class size (44) meant it was difficult (and unsafe) to do practical exercises in the overcrowded space.
- The school was ill-equipped for whole-class practical activities.
- There was virtually no budget for materials and the school had difficulties storing materials.
- The teacher wanted to increase pupil motivation by following their interests and finding their own needs.
- The teacher didn't want her limited expertise to restrict the pupils' potential. She had faith in the pupils' abilities to investigate and in her ability to guide their learning.

When the pupils brought in their models, the range and quality of vehicles was impressive. Almost all of the vehicles had a specific purpose and included specially designed features (e.g. wide wheels for the off-road vehicles). Almost all the vehicles had working wheels and axles; some had steering. Some vehicles were so big they didn't fit on the desktops; some were so small they fitted in a pocket. Most had been made using reclaimed materials. Some pupils made vehicles using construction kits and some used new materials.

I was concerned that most of the pupils' practical activity took place at home and parents would do a lot of the work. I also had concerns about the children with no support at home. However, I found that the pupils, who had help, worked with their parents.

They described their projects, the models' purposes, what they did, how their models worked and what they learnt. Most pupils who had not been able to get parental help had sought assistance from older siblings or other adults. All pupils had produced a model they were happy to show me and discuss.

When the pupils had completed their models they carried out group evaluations. All the pupils had mechanical understanding of their own models but more importantly had looked at each others. The pupils benefited from learning about the variety of designs and techniques used. They were able to comment on and evaluate each others' work using technical terminology.

The West Midlands School

Initially, in the West Midlands school, the teacher had shown the pupils a range of manufactured toy cars. They looked at them as a whole class and the teacher explained how the wheels and axles functioned. The teacher told the pupils that they were going to make toy cars and the pupils were excited.

In the first practical activity, the teacher introduced the pupils to Jinx-frame construction techniques and the whole class used them to make their individual chasses using wood provided.

The teacher used a model vehicle to show the class how an axle can turn in an Artstraw™ bearing. The pupils replicated this technique on their models by taping Artstraws™ to their chasses and inserting dowel axles through them. They learnt to cut Artstraws™ and dowels to fit the chasses. All pupils used the axles and pre-manufactured wheels provided. The pupils also constructed the bodies of their vehicles using Artstraws™.

Although there was some variation in shape, the models looked very similar. Many of the Artstraws™ had been taped too tightly, or attached with insufficient care, so the axles barely turned. By the time the projects were complete, though excited by the concept, many pupils were frustrated by their failure to work. Instead their attentions turned to the style and they played with their vehicles ignoring the inadequacies; they became less concerned about function.

The formal pupil evaluations revealed they were pleased with themselves but that the vehicles did not work well. Few pupils were able to explain why their models did not work. Frequently they thought the weaknesses were a result of the Jinx-frame and suggested changes that were mostly to improve it or focused on style.

As a voluntary extension to this project, three pupils made vehicles at home. The teacher encouraged any pupil who wanted to do this, believing they would learn more and that it would be good for them to work together with parents. The pupils were rewarded by getting stickers and exhibiting the vehicles, but the teacher did not use the models to elicit learning.

Teaching methods and priorities

The teachers at both schools had a similar understanding of the philosophy of Technology Education and the requirements of their National Curricula; indeed the policies share a common philosophy. However the approaches of the teachers differed dramatically.

The English teacher used a behaviourist 'transmission' (Cheeseman and Watts 1985; Wheldall and Glynn 1989), of his knowledge to develop mastery of physical construction skills and mechanical concepts. He was conscious of the National Curriculum requirements to be expositive and ensure he had clear objectives. These were pupil performance, the circumstances of performance and the criterion of performance. His focus seemed more concerned with "performance outcomes rather than learning outcomes" (Dakers 2005:84).

The South African teacher's approach was a constructivist process emphasising the development of a pupil's 'thinking' (Woods 1995; Wood 1998; Rogoff 1999), by interaction with the vehicle contexts. Her focus was the pupils' enjoyment through learning by investigating and constructing their interests and ideas on vehicles in a personal way; she spent less time monitoring individuals' progress.

Autonomy and authenticity

By bringing in existing products and an example of the vehicle he made, the English teacher stifled the potential creativity for the pupils. The pupils based their designs on his model believing this construction to be the 'right' answer. Whilst well intentioned, the teacher-led structure providing the context from which to develop their designing was too highly prescribed.

The South African teacher deliberately left it to the pupils to provide research; she made a point of not collecting examples thinking these could influence (and limit) pupils. The South African pupils' knowledge was mediated through meaningful contexts of their own choices. The pupils were encouraged to take inspiration from their home experiences and exposure to hand-made crafts they would see in their localities.

Open-ended, pupil-led design briefs increase the development of higher-order creativity. As Dakers (2005) explained "Pupils must have a sense of ownership of the scenario and must be given scope to develop their own solutions".

Collaboration

There was a great deal of collaborative activity in the South African class. Through this the teacher was able to integrate the pupils' internal knowledge and prior experiences to explicit external understandings. The collaboration occurred firstly in the class, with peers and the teacher, in the investigative development and evaluative stages. There was different collaboration at home with the pupils' families during the idea development and making stages of the activities. The teacher relied on the home experience that pupils brought. Although informal, this interaction at home enhanced the pupils' learning; they had the opportunity to talk through their thoughts with a range of people and through every interaction their technology capabilities developed. The collaborative activity built on the pupils' "zones of proximal development" (ZPD) (Vygotsky 1978; Bruner 1985; Cole 1985; Rogoff 1999), filling the gap between what pupils could achieve alone and their potential. Beetlestone describes the ZPD as a *two-way* process (Beetlestone 1998:14), acknowledging that the older collaborators (including teachers) also learn from the children. During the evaluation, the pupils enjoyed showing the variety in their creativity and made leaps in their understanding of the qualities of peer's models.

The English pupils also worked in groups but there was not so much gain. Rather than sharing individual experiences and knowledge, they shared materials and equipment. The initial whole-class introductions were conducted through the teacher. He answered individual responses so the class gained a little from the thoughts of their peers but this did not include the exchange of ideas between pupils. The final evaluative activities were conducted independently. There was no formal opportunity for the pupils to collaborate with people at home.

Resources, Materials and Time

Few materials were provided in the South African school so the pupils needed to be creative in selecting materials. It is not clear how much experimentation took place at home since preliminary work was discarded, but the quality of pupils' models indicated that they had become familiar with materials, tools and processes.

The English teacher provided all the materials. He planned the designing and making so he knew pupils' requirements. Such planning made the making processes manageable, but restricted the outcomes. The quality of the pupils' work indicated that, they did not have enough time to become familiar with the materials.

'Creativity' authors (Roden 1997; Davies 2001; Cropley 2004), say that pupils need opportunities to unlock their potentials by using and reusing unfamiliar materials. Lowenfeld and Brittain (1970) said that by limiting the range of materials or the time to become familiar with new materials, teachers hinder creativity and developmental thinking in their pupils. Time is required for this familiarisation and it has been widely reported, (Shallcross 1981; Davies 2001; Benson 2004; Dakers 2005), that the value of reflective periods is a vital component of creative learning. The South African children benefited from reflective opportunities at home.

Explaining the differences

The National Context

Although the teachers shared a view of Technology Education, the teachers' primary concerns differed; this affected their approaches. Since the late 1990s, teachers in England have experienced tensions balancing "raising standards and primary school child-centred ideology" (Pollard 1992:104-124). Beetlestone (1998:1) noted, "creativity has very much taken a 'back seat' since the advent of the National Curriculum, arguably because it is so much more difficult to deliver and assess than subject content." Jeffrey (2003) described how reforms have led to a "compliant response" by teachers to 'deliver' the curriculum The English teacher was driven by standards and fulfilling the National Curriculum. He endured scrutiny from OfSTEd , who expect fully planned activities *before* implementation; such planning inhibits the emergence of authentic activities so the teacher's approach was linear (contrary to the spiraling nature of Technology Education). It takes a brave teacher in England to plan the structure of "practice fields"…where learning is situated in authentic (contexts)" (Senge, 1994 cited by Dakers 2005:83) and guide them through autonomous learning.

The South African teacher had a different dilemma relating to prohibitively large classes, inadequate accommodation and restrictive funding. The consequence was, South African pupils worked collaboratively simply because their circumstances *demanded* it. The South African teacher valued the positive aspects of collaborative activity, appreciating how much the pupils learnt from each other. The interactions pupils encountered at home were "scaffolding" (Wood, Bruner and Ross 1976) their progress. She admitted difficulties in assessing practical skills, but importantly, she *could* assess learning. She was not exposed to the same scrutiny of her English counterpart.

Professional Development.

Both teachers lacked confidence in their own expertise to teach Technology Education. Their concerns were they had insufficient training and knowledge surety. The English teacher's response to this was to plan highly controlled projects with tightly constrained briefs; making him feel secure, he practiced designing and making and planned ahead according to his competences. Consequently, this limited the pupils' experience; many of the pupils' models were indistinguishable from each other, or indeed the teacher's. The pupils had learned but it was from a didactic approach with little collaboration and the learning was shallow.

The South African teacher believed she also lacked experience. She relied on the pupils' motivation and resourcefulness to gain knowledge they could disseminate collaboratively. She believed she could learn *from* the pupils and had the confidence to coach the pupils through the design process and maintain a child-centred framework. She knew that some pupils would have greater support at home than others, but planned activities redressing the imbalance by instigating effective peer education.

Conclusions

The English teacher had good awareness of his pupils' capabilities whilst the South African teacher had a strong, but less formal grasp of her pupils' attainments. In South Africa the pupils' attainment outstripped that of their English counterparts (even allowing for the age-group differences).

Some of the creative teaching methods adopted by the South African teacher were through 'circumstances' rather than through the positive choice. The real success derived from the teacher's confidence to risk, allowing the pupils to control their project development. She was confident in her abilities to guide the pupils' learning through the difficulties. There were unexpected benefits of large class sizes, minimal resources and teachers with insecure knowledge surety. Hence the title of this paper: – "Necessity is the mother of invention". I believe the South African children gained more enjoyment and greater technical literacy than the English children.

Clearly we have much to learn in England from the South African teacher's approach to creative learning. The good news in England is that creativity has not been lost entirely (Craft, Jeffrey et al. 2001; Jeffrey and Woods 2003; Alexander 2004). Teachers are finding the confidence to adapt strategies now that the Government have responded to the National Advisory Committee on Creative and Cultural Education's findings (NACCCE 1999) advocating creative learning, by introducing the Primary National Strategy (DfES 2003). Positive differences are being made specifically in Technology Education (Roden 1997; Davies 2001; Benson 2004). The next paper may show successes in England of assessment *with* creative learning and perhaps the South African teacher can learn from the English experience!

In carrying out this research, I am grateful to the teachers and pupils who generously gave their time for my questions and allowed me to observe Technology Education.

Notes

[1] OfSTEd = the Office for Standards in Education

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Excellence and Enjoyment, Compliance and Creativity – Can We Really Have It All?

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Abstract

Many teachers and pupils today are beginning to question current primary educational practice (Ogunleye, 2003, Wragg, 2003). They find themselves compliant to an overcrowded curriculum model based on content rather than pedagogy. Those who recognise that engagement and enjoyment is key to learning complain of frustration with a lack of opportunity to address teaching and learning more creatively (MacGilchrist, 2003, Hofkins, 2003). For those committed to broadening educational opportunities for all children so they can participate in the 21st century, is it not time to reconsider the current curriculum model that appears to be failing so many?

This paper reports on selected results of case study collaborative action research in the primary curriculum. It focuses on the implementation, in a class of Year Six pupils, of a cross-curricula project-based model where design and technology provided the integrative focus. This model sought to overcome a pedagogical dichotomy between compliance and creativity, raised by the Headteacher and recognised in the literature. The research addressed two important questions:

- ***Was it feasible, in a climate under immense pressure to focus on standards and measurement in the core subjects, to provide a broad and balanced primary curriculum model that embraced rather than marginalised the arts?***
- ***Would such an alternative model allow teachers to explore more creative learning and teaching methods and encourage greater levels of engagement on behalf of the pupils?***

The paper highlights the wider context surrounding the current primary curriculum debate. It presents selected findings which provide evidence to suggest that through the application of a process-led pedagogy it is possible to address compliance with National Strategies and the National Curriculum whilst at the same time enhance the creative potential of learning and teaching.

Introduction

This paper reports on findings from research carried out to explore the effects of the implementation of a project-based curriculum model where Design and Technology bravely took centre stage. The model sought to overcome a pedagogical dichotomy between compliance and creativity and to consider the possibility that a primary curriculum could actually provide excellence in terms of standards without ignoring an essential aspect of education: enjoyment.

The Context for the Project

There is little doubt that with a predominant 'performance model' (Pollard, 2000:24) of primary education more reminiscent of the nineteenth century we entered the twenty-first century. This is not to imply that primary education has moved little in the last 100 years. On the contrary, history relates that the role of primary education has shifted from its initial focus on developing practical skills and social abilities for life to one of preparing individuals for Standard Achievement Tests (SATs) that form the basis of a school's standing in primary league tables (Richards 2000:3). The compliance of primary schools today is perhaps reflective of a generation acceptant of, and socialised by, media rhetoric, economic driven policy and educational initiatives promoted more for political credence than pedagogical understanding.

The recent initiatives have placed pressure on the primary curriculum organisation, development and teaching and learning strategies are restrictive and formal. They encourage teachers to competitively prepare pupils for tests centred exclusively on literacy and numeracy enhancing school league table positions. The consequence is huge restriction on the amount of time allocated to foundation subjects and performance arts. What are missed from such a model are opportunities to raise not only academic standards but also pupils' self-esteem and to teach in a way that children develop a love of learning. There is little doubt the progressive model used in the 1960's encouraged methods which raised pupils' self-esteem and developed (for some) a love of learning (Blishen, 1969) but possibly at the expense of basic academic standards. As with the Elementary model of the 19th century, the current model does the reverse. I suggest one does not need to exclude the other.

It is encouraging therefore to note The Primary Strategy document: *Excellence and Enjoyment* (2003) suggests recognition of similar concern about our current primary curriculum model. The need for balance to be redressed in favour of creativity (in learning and teaching) and recognition of the need to utilise teacher's intuitive capabilities (Claxton, 2000) appears to be gaining ground. Whilst criticism that this report merely pays lip service to the cries of dispirited teachers may have some validity, I would argue some guidance is better than none and that many of the statements or suggestions for improving the current curriculum model provide credence for alternatives, seeking equal balance between excellence and enjoyment.

The Case Study Context

With similar concern that the current curriculum had already *'strangled the holy curiosity of enquiry'* (Einstein, cited in NACCCE 1999) for her pupils the Head teacher of a small rural school (130 pupils) sought collaborative support from the University of Brighton to review their curriculum model. Despite efforts on her part to retain aspects of creativity within the curriculum with regard to both learning and teaching, this Head was very concerned that children's work was becoming formulaic and that some of her pupils seemed disaffected. As a result many of her teachers had also become disillusioned teaching a curriculum which appeared as value laden in favour of the core subjects and didactic teaching, leaving no room for excellence in the form of true learning skills to be developed around the enjoyment of a varied curriculum.

Project Design

To explore whether a change in curriculum approach would elicit excellence and enjoyment on behalf of both learners and teachers a two week project was developed that endeavoured to incorporate National Curriculum subjects and complied, as far as was possible, to specific requirements of the National Literacy Strategy (NLS) and the National Numeracy Strategy (NNS) for the half term of the study period. It was deemed however, essential that creativity be firmly at the heart of the planned work. It was noted that many of the schools praised in *'The Curriculum in Successful Primary Schools'* (OFSTED, 2002) were reported to have *"a strong emphasis on arts, as this motivated pupils and contributed to their enthusiasm for school and education generally'*. My own passion for the arts and in particular my own expertise as a D&T educator left me in no doubt that Design and Technology should form the 'centre of interest' (Reggio Emilia cited in Katz 1994:52) around which the project-based curriculum was designed (Haffenden, 2004). Pupils were asked to "design and make the packaging and related promotional materials for a new Fairtrade chocolate bar". This allowed meaningful connections to be made between the taught cross-curricula content (skills, knowledge and understanding) and the children's own experiences (is there a child who has no experiences of chocolate?). A point considered essential if these children were to be truly engaged in the act of learning (Benson, 2002, Kimble, 2000, Davies, Howe & Ritchie, 2001).

Testing the suggestion that Design and Technology can be an 'umbrella' (Davies, Howe & Ritchie 2001) for curriculum development, the project aimed to provide a learning and teaching experience where subjects could interconnect but where content was still wide and varied. The emphasis shifted from a knowledge based curriculum to a skill based curriculum where the QCA criteria for creative pupils (QCA, 2003) provided the basis upon which to guide the proposed materials and strategies: questioning and challenging; making connections and seeing relationships; envisaging what might be; playing with ideas; keeping options open; representing ideas in a variety of ways, evaluating effects of ideas and actions.

Where possible much of the work that was due to be covered during that half term was incorporated into the materials and strategies. As the school had adopted the QCA Schemes of Work, the requirements for each subject were identified, as were those for literacy and numeracy. The requirements were adjusted to relate to the focus in as many ways as possible. For example where 'study of a distant place' in geography was the proposed focus, Ghana was chosen for its relationship to cocoa. Where persuasive writing was the emphasis in the planned literacy work, pupils were asked to create advertisements for their chocolate bars, and so on. The aim was to provide a holistic learning experience by intertwining the project focus and the required learning providing elements of both compliance and creativity.

It is worth noting that by identifying Fairtrade as a central aspect of the design work it was not difficult to also embrace citizenship into the heart of the project. As arguably an essential but non-statutory subject at primary level, aspects of citizenship are often ignored yet can interlink with Design and Technology content quite seamlessly. Many teachers feel ill prepared to teach such singular concepts perceiving them as yet another addition to an already overcrowded curriculum. Sadly the result is valuable learning and teaching is frequently left untouched. In addition, this wider approach to curriculum content, and the insistence that the final practical outcomes were as open-ended as possible, facilitated an ideal environment within which children could begin to develop Claxton's 'creative habits' (2004:24); the ability to tolerate uncertainty, being open-minded, risk-taking, questioning, being patient, deferring judgements, being resilient and showing empathy. Once again developmental areas of learning which are the keystone of good Design and Technology teaching and learning and valid reasons why Design and Technology need be at the heart of this curriculum innovation.

Research Questions and Methodology

Two key areas for enquiry were:

- Is it feasible in a climate under immense pressure to focus on standards and measurement in the core subjects, to provide a broad and balanced primary curriculum model that embraces rather than marginalises the arts?
    - Would such an alternative model allow teachers to explore more creative learning and teaching methods and encourage greater levels of engagement and enjoyment on behalf of the pupils?

A qualitative approach was adopted using a range of data collection methods. These included semi-participant observations, semi-structured informal and formal interviews with pupils, teachers, helpers and parents, case studies of six children, recipient diaries of all pupils, and sampled pupil work. A grounded approach (Glazer & Strauss, 1967) was applied to the data using constant comparative analysis. This allowed themes to emerge through the process from the data (Woods, 1982).

Findings and Implications

Two significant areas emerged worthy of discussion:

- *The initiation of a project-based approach to the curriculum led to a change in teacher behaviour, which then resulted in a change to the pupils learning experience. As a result, a subsequent change was observed in pupil behaviour. Put together these changes appear to demand a further shift in perceptions of the learning environment.* (Haffenden, 2003)
- Pupil Behaviour
  The best project work has always seized children's imagination, persuading them to work on their topic way beyond the constraining confines of their classroom. (Wragg, T. 2002:52)

Further analysis of the data derived directly from the pupils (diaries, interviews, observational field-notes and analysis of pupil work) suggested that changes in pupil learning, which occurred as a result of a widening of the curriculum content, had also caused significant changes in pupil behaviour. Such changes were demonstrated primarily in their attitude to the work and for many previously unmotivated children the project work had certainly appeared to 'seize their imagination' and 'persuaded them to work'.

The antecedent context had presented a picture of a mixed ability, fairly well motivated group of individual Year 5/6 children. I had met this class on several occasions throughout the year in my role as University Advisor and was familiar with the general ethos and behavioural expectations within the class. Positive changes in behaviour, that I believed to be as a result of the project, were frequently confirmed by Robert (the class teacher) as this random selection of comments demonstrates:

> *"I would say without a doubt that the children are far more engaged in their work today…"*
>
> *"They are switched on and they're really enthused…"*
>
> *"…they were more excited than they would normally be."*
>
> *"…they showed far more motivation."*

This was also an impression shared by the teaching assistant:

> *"Normally when we've done that sort of work (referring to a fair testing session) the results they've recorded were a bit all over the place and they weren't really that interested. But for some reason with this they were far more interested…I think it was because it was all leading somewhere, their whole attitude to work was completely different."* (TA Interview, 2003)

The data provided many references to specific behavioural change in all the case study pupils and there was an overall consensus between the staff and parents involved that most of the children had been noticeably motivated and enthused by the project itself (Haffenden, 2003).

> *"There was a real sense of urgency in Michael, which we don't usually see. He rushed into the room and got straight down to the task in hand…I think he needed to print something out. When I asked if he could spare a few minutes to help me with something, he (politely) told me that he really hadn't got time, explaining how he 'needed to get on' and then he quickly disappeared back to the classroom! Normally Michael would jump at an excuse to avoid getting back to work."* (TA Interview, 2003)

However, it must be recognised that future curriculum materials and teaching approaches should address the full range of learning styles and that pupils should be given guidance to develop independent learning skills from an early age. Serious consideration should also be given to the time duration of projects, relevant to the age range being taught, to maximise sustained interest.

Teacher Behaviour

There was much evidence from the findings that this project-based learning initiative challenged the traditional role of the teacher. During the project period the class teacher was required to use materials, which had no obvious subject specific content and was free to teach in any way he felt appropriate. As a result, the lesson structure and teaching approach appeared to change radically.

> *"Robert no longer stands in front of the class and has moved his desk to the side. He seems to be talking from many different places in the room which make him seem much more integrated."*

This new role required him to 'support' in a room where pupils were talking independently from the teacher, where the hum of heated debate was taking place, where decisions were being made without the confirmation of a teacher. I noted during one session many occasions when Robert was able to take time to discuss what progress the children were making. On other occasions I noted Robert was able to spend time discussing issues with other adults who had come into the classroom to ask for advice. During this time the children did not appear to deviate from the set activity, which so often happens when pupils perceive the teacher giving less then 100 per cent of his/her attention. These adult interactions took place during working sessions where pupils, without doubt, remained on task. On a separate occasion I witnessed a group of pupils discussing the subject area and asking each other questions, which they each in turn attempted to answer. It was obvious, as I eavesdropped, there was no assumption that Robert had the 'answers' and the children seemed happy to debate and discuss the issue in question without the support of a teacher.

What it seems Robert may have achieved is the presentation of 'work' in the form of shared learning experiences (Barnes, 1979, Wragg 2002, Claxton 2004). Learning which did not necessary require right or wrong answers but learning which needed to be 'experienced' rather than 'corrected'. What I am suggesting as significant is that 'teaching' appeared to be more about 'supported learning' than 'delivering knowledge' and that 'being on task' no longer required Robert to take a lead role of 'teacher in charge'.

> *"Children learn better if teachers, while being responsible for structuring the environment, act within that structure more as guides and assistants to the learners rather than instructors in the traditional sense."* (Gross, N. et al 1971:274)

Significantly in his new role of 'guide', Robert saw little problem in giving pupils an opportunity to even share in the planning process with regard to the timetable. As Robert commented:

> *"… what is important is that we (the class) are able to develop it (the content) as we go along. Because we could see that there was a need to add other things in when some things were going really well it was the children who have suggested what needs to be adjusted."*

Robert's comments above are particularly significant as they refer to an occasion where it was the pupils who negotiated a change in the planned sessions. The implication here is that timetables should be flexible and schools should consider the concept of blocked sessions for consistent learning when considering using such an integrative curriculum model.

If such a model is to be considered, the shift in perception of the role of the 'teacher' will require the development of a new mindset where teachers will need to consider adopting a more facilitative role in which they no longer take a predominantly hierarchical position but one that shares in the learning process. Teachers will also need to be prepared to be adaptable and be given opportunities to trust their intuition with regard to planning, teaching and organising. These are significant implications for INSET and ITE.

Conclusion

The findings here indicate that, with careful planning, the designed curriculum requirements could be integrated into a single D&T focus project. Once the centre of interest was identified, subject-specific work could be 'seamlessly' (Haffenden, 2003) related. To avoid the accused superficiality of the Plowden inspired curriculum model the subject-specific programmes of study provided by the National Curriculum were not rejected but used to direct the learning. By focusing on a D&T centre of interest for a two-week period, the learning potential of each subject took on a relevance (not only to other curriculum subjects but to the children themselves), which prevented a dislocation of learning. This allowed specific children to assimilate knowledge and understanding at their own pace making links between subjects. Whilst there was recognition for the need to include some direct teaching of literacy and numeracy, relevant application to the centre of interest allowed children to apply their learning in a meaningful way. Moreover, opportunities for learning and teaching related to aspects of language outside the NLS requirements (speaking and listening, drama and role-play) increased. As a result significant development of personal and social skills were also a feature of the experimental period (Barnes, 1979, Wragg, 1997, Claxton 2004). Confirmed through the data, there was also a marked improvement in levels of engagement. For many this culminated in an increased standard of work and some noticeable changes in self- esteem (Bruner, 1983). One child's observation that the learning was 'inside the chocolate', confirms the holistic nature of the learning and teaching which for some children dispelled their own negativity regarding subject-specific ability.

The inclusion of practical creative work as the catalyst for the centre of interest not only raised the profile of the arts but allowed non-statutory curriculum areas to fit naturally into the learning and teaching (Davies, Howe & Ritchie, 2001). Where creativity is concerned it was not just the learning or pupil outcome that addressed the QCA creative learning criteria but the project-based curriculum also impacted on the creativity of the teacher and the teaching environment (Harrington 1990, Claxton 2004). Moreover, creative teaching approaches addressed a wider range of learning styles (Gardner, 1993) and therefore provided access to the curriculum for a broader range of pupils. Although the philosophy behind the pedagogy was a focus on the learning process rather than the content, the content was not contradictory of government requirements.

This paper suggests there is no need to choose between conformity or creativity and that in reality one can be used to support the other in continued pursuit for both *excellence* and *enjoyment*. Indeed, it appears, we can have it all.

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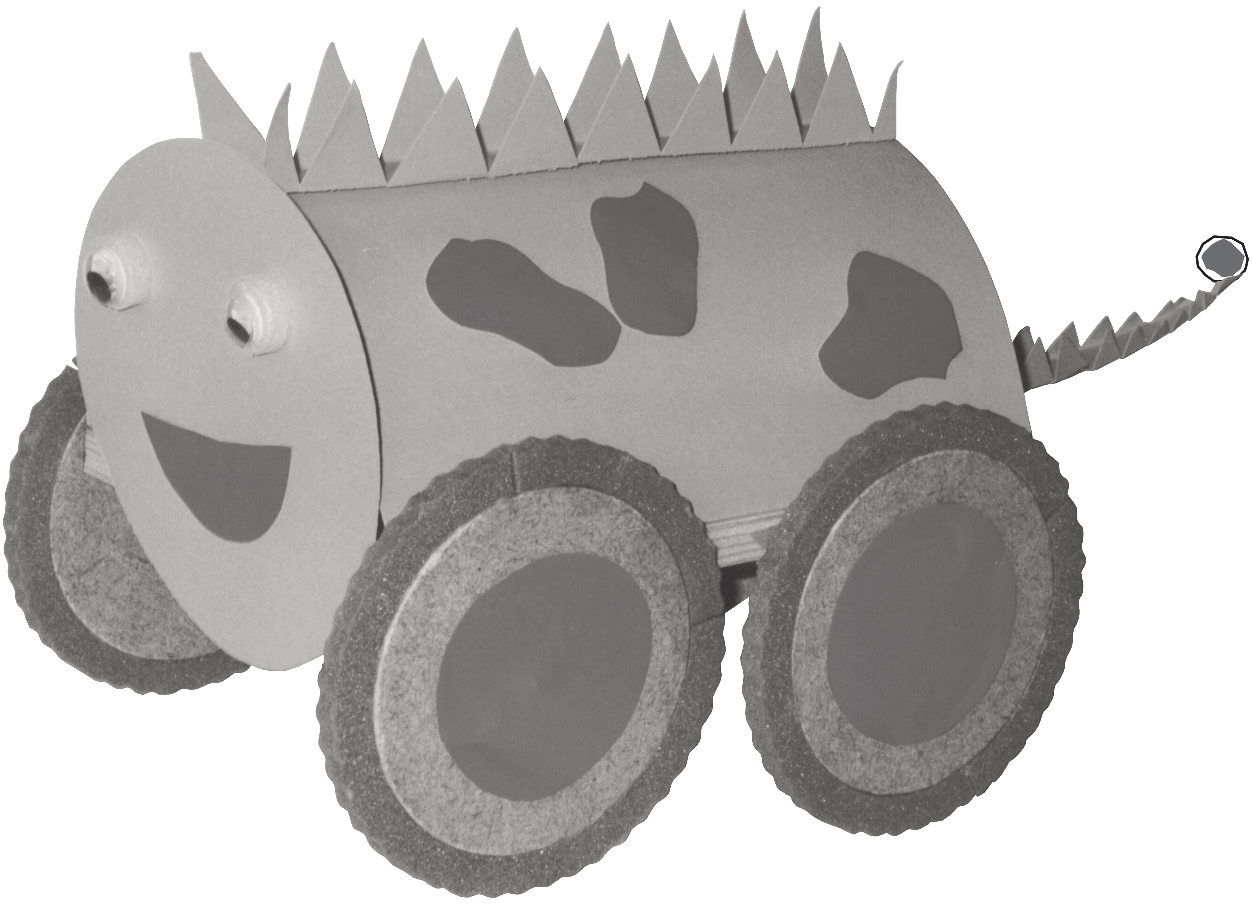

Research on "Community Art Map" Curriculum and Creative Teaching at Primary School

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Background

The creativity of elementary school students mostly comes from learning. Both curricula and extracurricular courses can inspire their potential and train the coordination of their sensory abilities. Those courses can also cultivate the students' adaptation to a new environment and further arouse their curiosity and learning desire. Teachers can also encourage students to explore questions and solve them themselves, which is also a kind of creativity. The purpose of the nine-year compulsory curriculum for junior high school and elementary school declared by the Ministry of Education in Taiwan and implemented from the year 2000 has also set a goal to cultivate students with abilities of active exploration and research and of independent thinking and question solving. In order for the eduction to run smoothly, the creativity education White Paper of the year 2002 has also proposed six preliminary initiatives: 1) Training of Creative Students Cultivation; 2) Growth Project for Creative Teachers; 3) Construction of Creative Schools; 4) Proposal of Creative Life for All; 5) Creative Think-Tank of On-Line Learning; and 6) Continuous Growth of Creativity (Ministry of Education, 2002). Therefore, it is essential to enhance students' creative thinking abilities in this competitive century with technology and brain battles.

There are many historical sites and temples which are both historical and artistic in different communities in Taiwan. Children growing up in these communities should have special connections to the landscapes in which they live. Every landscape and picture serves different purposes, and every child should also have their landscapes and pictures in their minds. The maps of earth, butterflies and life which children care and are interested in can help them shape an alternative hope for the future. On the basis of this idea and from the viewpoint of community features, I have motivated to develop the curriculum of art appreciation and creation, combined with visual art, music, performance and exhibitions to enrich children's learning and to deepen children's sense of identity to their hometowns. The purposes of the research are as follows: 1) To develop creative thinking on art instruction patterns and curricula; and 2) To explore teachers' processes of creative thinking on art instruction and their reflection on the instruction.

Ideas of Community-Based Art Curriculum

Community-based art curriculum adopts the spirit and viewpoint of multi-cultural education, and puts more emphasis on the integrity of cultural life in communities. Therefore, the curriculum and instructional content should make people of the communities, their lives and human environment as the main focus.

The research holds that the community-based art curriculum should have features as follows (London, 1994; Sahasrabudhe, 1922; Blandy & Hoffman, 1993):

1 Educational Ideas: The curriculum emphasizes the integrity of education and community life and cultural values by using community resources, learning community features and the pattern of interactive cooperation in communities, and by pursuing the understanding and identity of their cultural environment.
2 Curriculum Design: The curriculum aims to take the related concepts of history, culture, social development from related people, things and places in communities and to extend to integrate other subjects with related concepts. The process of learning is meaningful and the resources can be reached both inside the classroom and out.
3 Instrucational Content: Knowledge dissemination and skill acquirement have no longer been limited to textbooks. However, knowledge and skills can also be acquired through historical and cultural environment of communities, symbol communication systems, social styles, the values, policies and resources of communities and through related concepts and issues.
4 Instructional Strategies: It is essential for both teachers and students to observe communities and analyze their exploration. Furthermore, they can use their abilities of judgement and knowledge-building to meditate upon the whole cultural background of communities.

Transforming Ideas of Art Elements of Community Landscapes

Interest and the activities which people are familiar with are indispensable. Interest is the tendency of people knowing specific things. It motivates people to pursue certain knowledge with positive attitude. Whether a curriuculum is practical or not, it depends on teachers' knowledge on a certain subject and on their creative thinking (Liu, Wei-Ping, 1999). While designing teaching materials, teachers should choose, deduce, reason and reorganize the information gathered, and use their professional knowledge to initiate the whole learning process. However, if the teaching content matches school's resources, it would be easy for students to observe and put much effort in the curriculum (Ma, Su-Mei, 2002). The six transforming patterns of art elements induced by the research are as follows:

1 Pattern of Imitation and Re-Creation (A)

This is a preliminary creative pattern. Its meaning lies in cognitive values, and it inspires people's imagination. People can use their imagination and concrete analytical abilities to transform the outline of the pattern into other symbolical items. For example, students can first sketch stone lions of Wan-Xing Temple, and then, teachers can let students use different materials to make lion masks of their own.

2 Pattern of Related Thinking (B)
This pattern is guided by relations between every element in materials. In this pattern, students would experience idea association and let every element generate relation association when being linked. For example, cause-and-result relation, subordinate relation, part and whole relation, function and effect relation and so on.

3 Pattern of Concept Analogy (C)
Based on some identical attributes of two phenomena and through thought comparison, the pattern is an inference method which induces their other attributes are also related. The usual style of the pattern is personification and surreal changes. For example, trying to introduce western elements to Chinese subjects and letting students create engrossing surreal works.

4 Pattern of Similar Image Analogy (D)
The pattern uses analogy transformation, adopts integrative organizational strategies to let two different arts mingle naturally and become a new creation. For example, the integration of Chiaochih pottery and heritage bookmarks.

5 Pattern of Art Transformation (E)
The pattern transforms traditional artistic styles by letting students change the styles of subjects in a new field and by making it meet the demand of new materials: simplified, flattened and lined images and color combinations for the purpose that it achieves the development of forms.

6 Pattern of Cross-Art Integration (F)
The pattern decomposes and reorganizes partial attributes already known and requirements needed to achieve certain goals to let students meet their needs while solving problems. The pattern asks for the solubility of questions, value evaluation, reasonableness and practicability.

Research Method

There are eight members in this research team, including one professor setting up the framework of the research and leading the team, and one principal and six elementary school teachers taking charge of the supervision of the research and of actual teaching. The research aims to be launched in She-Kou Elementary School in Taichung County. The subjects of the research are the third, fourth, fifth and sixth graders of the school. The core course is the “Community Art Map” complied by the research team, and it has adopted creative thinking instruction.

The research method is both quantitative and qualitative. Its information-gathering instruments include observation method, on-site visit, workshops, sharing of curriculum development results, interviews with local folk experts and with students, work analysis, questionnaire and so on. The research gathers effective information and offers prompt feedback, and it is, therefore, a real-question-solving-oriented research. In addition, the research makes the observation records of instruction for every unit in detail, so that teachers can reflect upon the curriculum to make it a better one. The steps of the research are as follows:

1 Proposal of Research Plans.
2 Curriculum Design: The historical sites, landscapes, temples and life of She-Kou City are used to design the school-based art curriculum.
3 Implementation of, reflection upon and refinement of instruction.
4 On-site observation, feedback gathering and result assessment.

Research Results

The research team constantly reflects upon and refines the process to develop a school-based curriculum. Combining community landscapes with creative instructional strategies, the systematic 32-unit “Community Art Map” of art and human-based curriculum is thus developed. The curriculum is suitable for She-Kou Elementary School and other nearby elementary schools. The “Community Art Map” has presently developed the courses for the third, fourth, fifth and sixth graders.

Reflection on teaching

1 Ideas and Reflection
I frequently think that teachers should teach people, not books, and that we all anticipate children to enjoy and observe people and things of the communities in which they live. They can also put down roots in this land with sharper minds. Wherever they will be in the future, it is significant for them to be proud of their hometowns, to be confident in themselves, to have families and career of their own and to have wonderful memories of their hometowns. Their generation has the responsibility to influence the next generation which means the continuation of spirit and affection, and which also means the greatest value of the existence of the elementary school (Teacher Tseng).

As far as I am concerned, local culture and educational profession have been promoted and many educational thoughts have also been revised during the research. At the beginning of the curriculum design, I only had some concepts of art education, but I was eager to try different teaching methods. I wanted to see if these methods worked, so I added many theme activities to all units, which were actually not practical. As I had expected, it turned out that what I did diverged from the essence of art education. After the discussion and revision of the teaching team, I got rid of individualism and started reviewing my curriculum design. I have also learned to take art elements out from the

Community Art Map

	Grade			
Community Landscape	Third Graders	Fourth Graders	Fifth Graders	Sixth Graders
Historical Site of the Third Rank-The Lin's Mansion (Dai-Fu Mansion)	• Exam Passed Tablets A (Three-Dimensional Clay)	• Overview of Community Historical Sites F (Architecture Forum)	• Blessing Walls Pottery Plate E (Chiaochih Pottery)	• Super Guide-Have Fun at Dai-Fu Mansion E (Computer) • Propitious Paintings Bring a Prosperous Year C (Creative New Year Couplets-Changing Words into Pictures)
Historical Site of the Third Rank-Xiao-Yun Villa	• Xiao-Yun Attic A (Three-Dimensional Cardboard)	• Open Your Inner Window D (Window Design)	• Taiwan Folk Songs (Lu, Quan -Sheng)	
Pastry Shops of Ten Decades (Li-Ji Pastry Shop, Kun-Pai Pastry Shop)	• Moon Cake Boxes A (Three-Dimensional Origami)		• Pastry Molds F (Carving and Card Printing)	Print Fun B (Getting to Know Printing Molds and Printing Art)
Traditional Temple (Wan-Xing Temple)	• Stone Lion Sketching A (Crayons,Water Color) • Masks of Dancing Dragon A (Crayons, Straws)	• Dragon of She-Kou E (Patchwork of Color Paper)	• Jewelry on Paper E (Making of Heritage Bookmarks) • Modern Gate God E (Water Color)	• Lantern Festival Celebration B (Making of Sky Lights) • Lantern Festival Celebration B (Lantern Making)
Grandpa Stone	• Stone Coloring C (Crayons)	• Birthday Party for Grandpa Stone E (Comic Strips)	• Blessings on Roof B (Picture Book Appreciation)	
She-Kou Elementary School (Computer)	• Citations from Sports Meet E • Dialogues of Flowers and Trees E (Flowers, Plants, Water Color, Printing Art) • Plant Bookmarks from She-Kou E (Leaf Bookmarks)	• Wish-Making Dolls E (Paper Cutting) • Making of Blessing Walls E (Water Color, Tissue Paper Patchwork)	• Making of Blessing Walls E (Ceramics)	• What's CIS?-Class Image Design E (Making of Class Flags, Badges, Clothes and Invitation Cards) • Tree of She-Kou C (Compound Material Patchwork) • My Future is not Only a Dream C (Pottery Plates, Mosaic Tiles)
Streets and Landscapes of Community	• She-Kou City 2002 F (Poster Making)	• Community Map Here's My House F (Painting of Simple Map)		

Notes: A Pattern of Imitation and Re-Creation; B Pattern of Related Thinking; C Pattern of Concept Analogy; D Pattern of Similar Image Analogy; E Pattern of Art Transformation and F. Pattern of Cross-Art Integration.

activities and to extract the good parts of them to design suitable curricula. Learning has made me realize what I lack. After starting designing curricula, I have realized that it is necessary to promote professional abilities rapidly and effectively. In order for the whole research to run smoothly, we have adopted the action research method. We have cordially invited quite a few experts outside the school to guide us and give us valuable advice (Teacher Yang).

A team supporting each other and working together for a little over one year has made me realized the spirit of "Flying Geese

Theory." Everyone feels tired at some point, but we can always find someone to continue the missions we have set up. Also, growing up with my partners is a priceless experience (Teacher Wang).

2 Problems that Challenge Us

Lesson plans are normally limited to one basic pattern: students are asked to create a work of their own after appreciating others. However, in this research, I want to make a breakthrough in cognition to skill performance because the cognition of communities must be based on "human affection", and skills are only a part of the process. How to start from the spirit of communities and how to cultivate students with sincere affection are the greatest difficulties I am now facing during curriculum design. In my actual teaching, I constantly draw myself from the complicated phase of teaching back to the phase of human spirit, which is what the "Community Art Map" requests. This truly is a big challenge to my curriculum design ability. In addition, it is a key to communicate and work with other teachers of art and human area. Teaching features and various concepts often test the relationship between and attitude of teachers (Teacher Tseng).

In this research, we have faced and solved many problems: changing thoughts to practical steps, integrating everyone's opinions to work toward a common goal, adjusting every team member's steps, boosting team members' morale when needed, making the most use of resources and time to record art elements in communities, discovering outside resources when profession is challenged, eliminating pre-service teachers' anxiety when the curriculum comes out, turning disadvantages during demo-teaching into a motivation for revising the curriculum and so on. A question solved is a milestone in the growth of the team (Teacher Yang).

I have started gathering textbooks from various publishers in the hope that I can induce a reasonable teaching procedure and design a creative and informative curriculum which matches unique local landscapes. However, even though every version of textbooks has been examined by the Ministry of Education, they still vary in basic music abilities and in goals they have set up for students. Therefore, I have come up with a blueprint myself: on the basis of the competence index of music textbooks of every version, I can select the most basic abilities for each grade to take the visual art and performance courses of the " Community Art Map." I have also tried to change teaching strategies. Meanwhile, it is important to keep the instruction as creative as possible. In this research team, I was the only person to take charge of the music course. When I encountered any difficulties, I hardly had anyone to consult with. Thanks to several enthusiastic team members of mine, however, they gave me a hand when I needed and kept giving me suggestions. Therefore, I was not alone. What's even better, the school and teachers in art and human area came to our assistance and gave us great support in administration affairs. Furthermore, we had a kind and enthusiastic professor from National Taichung Teachers' College who prepared us with whatever we needed and who brought us various new concepts and interesting ideas. These people have injected some much-needed vitality into the research (Teacher Chang).

Suggestions

Most students nowadays have less and less creativity and imagination. In fact, it also shows that the current education has made students retrogress to little creativity and imagination. Therefore, it is essential to use appropriate teaching strategies and materials and to establish an instruction-friendly environment to help students retrieve their creativity and imagination. We sincerely hope that in the future, the research team can spread their ideas to other teachers and to the curricula of other areas. We also hope that our perseverance can give teachers confidence and let cooperative strength expand from schools to the whole community and even to the whole country.

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A Study of the Acquisition of Technical Competence using Girl-Friendly Science Instruction in Primary School

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Research design

In a school project of Lower Saxony, Germany, called "social integration in a primary school suitable for boys and girls", a practical experiment of girl-friendly social studies and science instruction was tested for three years next to other interventions.

This social studies and science instruction is based on the following didactic principles developed in a local and ecological elementary social studies and science workshop called RÖSA (www.roesa.de) and the following concept presentation (www.lesa21.de):

This concept has already been tested for several years at the University of Oldenburg, Germany, and in the elementary social studies and science workshop RÖSA. In its core this concept of social studies and science instruction is concerned with specific, self-developed working materials to achieve an exploring, problem focussed learning for the children.

The meaning of this approach is to enable the children to consciously form their own learning processes. By following up their questions, they learn how to search for their own solution and how to exchange different possible solutions of the groups or learning station. The starting point of such a social studies and science class is always a certain content or a topic based on a question given by the children-thus relevant topics. After that they test their solutions by making their objects out of 'almost-waste'-materials. They can work in groups, at learning stations or individually according to the buffet concept. Subsequent to the working phases there is a discussion about the different solutions in the whole group. During this phase and the previous planning stage, communication and exchange of different solutions takes place. This concept wants to show that there is not just one eligible solution in the way it is taught in traditional established teaching. This concept desires different perceptions and, due to diverse testing conditions, asks for different opinions, ideas and solutions to be discussed equally in an exploring way of learning. There is a reversal of the hitherto applied ways of social studies and science education, which is generally dominated by a hierarchical structure and learning processes that only cater for reproduction of knowledge; whereas in this concept the acceptance of diverse solutions, different perceptions and miscellaneous approaches is essential. In this acceptance of difference lies the main didactic-conceptual core of communicative social studies and science teaching. (cp. Kaiser 2004)

This didactic approach emanates from the assumption that experiences gained in the learning process essentially influence the learning results.

Here the aim is to test a communicative didactic concept, which involves the following characteristics:

- Knowledge requires intersubjective communication.
- Contents are not clearly definable, they trigger different subjective interpretations.
- Natural processes and time/work rhythms are to be taken seriously.
- Equality instead of hierarchy is to be postulate.
- Social dimensions of caring for each other will be unfolded.
- Paradoxes are tolerated.
- Differences within people and opinions are focused upon.
- The social competence hitherto rather associated with female competences is to be developed to a generally accepted value and to a main didactic principle.
- Aesthetic, communicative and ethic-philosophical approaches to contents are equal to cognitive ones. (cp. Kaiser/Pech 2004)

These didactic outlines, just mentioned, are to be put into practice through annually two chosen major projects for social studies and science education.

Such an integrated communicative social studies and science education seems to comply with the postulate of Wagenstein: "In coeducational instruction I have always made the experience that when you conform with the girls it is also right for boys, but never the other way round." (cp. Wagenschein 1965, p. 350).

Graphically visualised, such a social studies and science education would simplified consist of the following components which clearly differs from the traditionally practised concepts in Germany.

Girl-friendly social and science instruction (Girl-friendly science and technology)

Communicative social studies and science instruction, suitable for girls and boys, is furthermore orientated to an appealing approach towards contextual scientific contents, which in particular addresses the interests of girls (cp. Kraul/Horstkemper 1999, p. 5). This concept wants to show the female achievements especially in the scientific contents of social studies and science instruction.

Throughout this school project and preceding conferences, pedagogical meetings, further training, this approach to social studies and science education has unanimously been accepted as a positive and important one. In concept descriptions of own school projects carried out by the participating teachers certain elements reappear. All in all, four schools in Lower Saxony had been involved in this school project for three years throughout the first to the third grade.

Contrasting concepts		
• Alternative concepts	Traditional social studies and science education	Communicative social studies and science education
• Pedagogical working model	Teaching knowledge passed down from the top, Didactic reduction of already existing knowledge	Proactive construction of knowledge by the children, children learn from each other, children appropriate the world together
• Underlying social model	Hierarchic structure, Predetermined learning matters which are to be taught in school	Democratic society in which all human beeings decide about important contents and goals
• Didactic goal	Predetermined elements of knowledge or mnemonic sentences	Exchange of different results
• Underlying learning model [1]	Bereft of content, unspecific	Cumulative, constructive reasonable-meaningful
• Methodical principles	Class orientated learning, reception of learning matter	Differentiation into groups and learning stations or individualised learning
• Didactic principles	Accumulation of knowledge	Research learning Hands-on learning
• Course	Order of learning matter teaching and knowledge testing	Communicative exchange about diverse possibilities of solutions in turn with differentiated working phases
• Differentiation	Equalised course	Topic orientated diverse hands-on tasks for children

[1] *For a comparison of these two learning models, cp. Soostmeyer 1999.*

Evaluation approach

We did not want to only analyse the results of this school experiment with the external instruments of the classical research equipment, but also wanted to find a way that would reflect the pattern of our conceptual design. Therefore we chose an experimental arrangement that would show the essential contents and goals of a communicative social studies and science education and that would picture the goal of social competence symbolically condensed.

As the starting position a story of Merlin the wizard was read out aloud:

> *"Merlin, the wizard, is sitting in a tower. He has been captured by an evil queen. Merlin possesses a magic egg that can give him magical powers. But the evil magical powers of the queen prevent the magic egg from working in the tower. The queen wants to take the wizard's egg away to use its magical powers for her evil purposes. Merlin has to try to throw the egg out of the tower. However, he knows, only when the egg reaches the ground safely the magical powers will unfold and break the powers of the queen. That way the wizard would be saved."*

In this hands-on 'test situation' the children receive an unboiled egg. They have to solve the problem of getting the egg safely on the ground together by communicating with each other. Afterwards they have to test their solution in a practical experiment. Like in the previous social studies and science education – a variety of materials is provided for the children. This activity is carried out in small groups of five or six children in which boys and girls corporately have to find a solution.

To solve this task there are several different possibilties to be found as has been seen in the pre-test with university students. The following ideas have been collected with the students:

- The egg is wrapped safely with a cord around it so that the egg can be let down slowly to the ground.
- The egg is put inside an airbag which is pumped up by means of a plastic bag.
- The egg is put in a bag filled with cork.
- A parachute is build for the egg.
- A jumping sheet is placed on the ground to catch the egg safely.

Evaluation results

Similar creative approaches to the egg-problem can also be found in the experiments of both boys and girls. They also developed several creative solutions. This experiment has been tested in six classes of a school experiment at the end of the third grade. Overall 28 small groups were involved in this experiment. Out of reasons of the practicability, only 17 groups were picked at random and qualitatively analysed.

Regarding the stereotypical male way of socialisation, it had to be expected that as this task was of a technical matter we would find a dominance of male activities in the groups.

Only the necessity of cooperation between the pupils in order to find a solution for this task was to hold back that assumption. In an established conservative point of view this skill rather belongs to the female competences.

By the end of this school project a realistic expectation was fulfilled as in the realisation of this certain experiment several boys and girls did not accomplish with certain gender specific behaviour patterns. In three years of this school project they had been given means in order not to act in gender specific attributions.

The results of this experiment fulfilled our expectations to a great extent. This will be demonstrated in the following excerpt of a protocol.

Succeeded group cooperation between girls and boys

In six out of 28 groups girls and boys worked well together.

Girl 1: " It's not very professional. It's too heavy."

Boy 2: "May I for a second?" He takes it and tests how heavy it is.

Girl 1 and girl 2 make the construction more stable.

Boy 2 and boy 1 watch.

Girl 1 and girl 2 improve the parachute. Boy 1 holds the balloon for them.

UPSK4/2000/06/22k Klasse3b

In this excerpt you can find a clear form of cooperative activity. One girl notices a technical weakness in the shared construction while a boy verifies the result of the girl. The consequent improvement of the construction is done by the girls while the boys watch what they do. One of the boys also gives help when it is needed.

Boy 1: "We made this and actually there is nothing much to say about it." He shows the egg.

Teacher asks who has had the idea.

Boy 1: "All of us"

Girl 1: "But mainly boy 1."

UPSK3/2000/06/05k Klasse 3c

During reflection on the group activity the boy notices that the result is a corporate product. On enquiry of the teacher about who has had the idea for this experiment set-up the boy names the whole group. Only the intervention of one of the girls makes his contribution to the group's achievements visible. Thus, in favour of the group, the boy dispenses with the accentuation of his contribution and looks at the product as a shared result.

This shows the efficiency of the group cooperation.

Groups with a dominance of girls

In 18 groups there was a definite dominance of the girls in the realisation of the 'test situation' which is demonstrated in the following example of interaction.

Girl 1: "Can I throw it down?"

Girl 2: "No, both of us."

Girl 1: "OK"

Boy 1: "I want to throw it down, you have already done everything."

Girl 1: " But you have painted."

Boy 1: "OK, then boy 2, he hasn't done anything."

Girl 1: "No, we. We have made it."

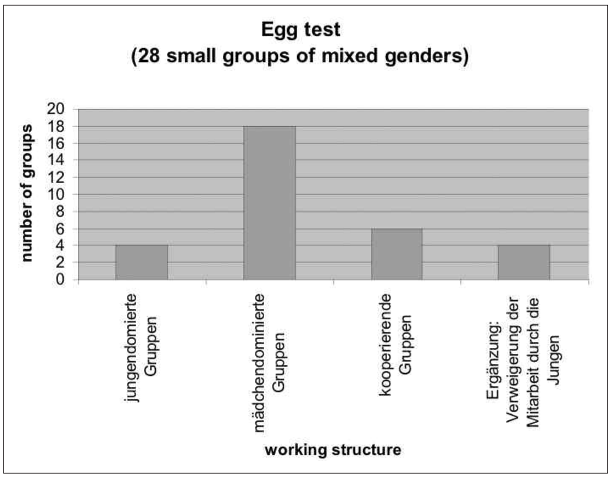
UPSK4/2000/06/22k Klasse 3

In the group, consisting of two boys and two girls, one boy completely backed out of the collective activity. Though the other boy has painted the egg, he has not contributed to find a solution to the task. Both of the girls, who together have found an answer to the problem, finally insist on carrying out the experiment themselves to prove if their idea is realisable in a practical test. They do not give in to the boy, who demands that he or the other boy should carry out the experiment because otherwise they would not have done anything.

All in all, it was obvious that in the majority of the groups especially the girls introduced technically relevant suggestions, in comparison to fewer solutions in boy-dominated groups.

Conclusions

Mainly, the egg test shows that it is difficult for girls and boys in primary school age to work together in mixed groups. Only a few groups developed working structures which were not sexually connotated. Though in contrast to our expectations, mainly the girls dominated the group activities despite the technical task.



Translation – Boy-dominated groups; Girl-dominated groups; Co-operating groups; Complement: denial of cooperation by the boys.

Surely one reason for this may be that there are communicative and cooperative competences required in such a task, which are rather accredited to girls. Besides, the item of the experiment, an egg, belongs to everyday materials, which is anyway in a scientific learning context rather appealing to girls (cp. Hoffmann 1997). Also the integration of this experiment in a situative context by means of a story rather accomodates the structures of motivation for girls.

Despite all these variables for girl-friendly science and technology, explained above, it is still astonishing that the girls are not put off by the scientific design of the experiment. They rather felt encouraged to prove their competence in this area and showed it towards the boys. In diverse protocols the problem shows that the boys cannot work cooperatively together. They try to find solutions on their own without enlisting the assistance of the others. The realistic hope that in this experiment an offset of the acquisition of social competences after 3 years of experiments in school can be found, has been verified. This leaves us to annotate that achievements of this experiment, especially for girls, can be acknowledged.

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Achieving Excellence in Teaching Through Practitioner Research, using Design and Technology Education Processes

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Abstract

What is practitioner research, how does it work, why is it important and how can design and technology processes inform practitioner research? These questions centre on gaining understanding of one's own teaching practice in order to improve upon it. This paper aims to examine the role of practitioner research in teacher professional development and suggests a methodology to facilitate this process. In order to maximize effective teaching and learning, critical and reflective investigation in one's own teaching may result in improved practice, because by using systematic and well-organised ways, appropriate methodologies that facilitate investigation of own practice can be developed and shared as a means of transforming teacher learning. The concepts discussed in this paper focus on introducing practitioner research to those teachers who are not familiar with the concepts of practitioner research and it introduces research to those who are perhaps new to the profession. There are many reasons for participating in practitioner research and there are numerous factors that shape and define practitioner research. I hope to this paper, and the simple structure that I propose, will initiate ongoing enquiry into own teaching practices so that a critical, reflective mindset develops that can be used as a basis for further professional development.

Introduction

Teachers who are genuinely concerned about improving their own professional practice can consider the reflective and evaluating practices employed by their own students within the context of design and technology learning. Applying the students' research and evaluative methodology, particular to design and technology education, assist teachers in exploring their own notions of teaching, their classroom practice and the effect of their actions across a wider education spectrum. Conscious awareness of teaching skills and attitudes frees them from the original context and affects views of the self and the world. Conscious reflective thought gives access to ideas and beliefs and allows for modification of these (de Boo 1999: 2-3)

The theoretical framework proposed is developed from design and technology processes commonly used by students in a primary classroom. The use of this methodology is important also in that it provides a language and system accessible by teachers of varying levels of expertise, because 'the challenge is to reverse the disconnectedness of the present world and to develop a curriculum that is not based on separateness of knowledge from life and being, but upon their inherent unity and integration' (Lovatt and Smith 1995: 248).

What is practitioner research?

Practitioner research in educational settings is nothing new. However, the very concept of research can be a source of confusion or dread for those not commonly engaged in research or those new to the profession. Variously known as action research or teacher research, individuals or groups engaged in practitioner research critically analyse and evaluate the practice of their own teaching. Sachs (1999) identifies four main reasons for this research:

1 As a strategy for a broader change initiative within the school or classroom
2 For the improvement of classroom practice
3 As a contribution to the understanding of the nature of teachers' knowledge base
4 As a basis for teacher professional development (Sachs 1999: 39)

Analysis of practice forms the basis of teacher reviews, school system enquiry, investigations into student learning and professional development. The research mostly takes place within the context of the school/classroom and focuses on developing understanding of, and improving own practice. The evidence that is analyzed and evaluated is often an amalgamation of information gathered in interviews, focus groups, questionnaires, observations, documentary evidence and so on. What these appraisals have in common is firstly the desire to analyze and evaluate the findings against set criteria, in order to make meaning of own experiences, and secondly to act as a significant source to develop ways for improvement in practice.

Why engage in practitioner research?

Practitioner research has the potential to generate genuine and sustained improvements in schools (see: Carter and Halsall 1998, also Day and Sachs 2002). It gives the teacher the opportunity to reflect on, and assess their teaching; to explore and test new ideas, methods and materials; to assess how effective the new approaches were; to share feedback with fellow team members and to make decisions about which new approaches to include in the team's curriculum, teaching and assessment and evaluation planning. The value of reflective practice lies in the fact that teacher actions will be better considered, and thus both teachers and students will benefit (see: Spalding and Wilson 2002). Searching for indicators that signify practice, interpreting this data and developing models to improve and evaluate practice lies at the heart of practitioner research. In other words, practitioner research critically investigates and reflects on past and present practice, in order to plan future action. Thus a key element of practitioner research is the ability to reflect on contextually based practice in an honest, objective manner.

Reflective practice

Barry and King (1998) consider reflection as an essential skill for teachers. They differentiate between the teacher who 'ponders about how well the skill, strategy, lesson etc. is going or has gone' versus the teacher who 'systematically reflects on a lesson' (Barry and King 1998: 409). Sachs also argues the importance of a proactive, responsible approach to professional development grounded by self-reflective practice (Sachs 2005).

Continuous, focused reflection leads to the valuing of learning, the learning processes, encouragement of lateral thinking, the transfer of earnings to alternative settings as well as fostering innovative styles of thinking. Thus practitioner research is a procedure whereby one reflects on one's own practice as a conscious and purposeful process, in which the individual actively embraces challenges and considers appropriate, informed, ethical processes, to allow for the transformation and improvement of practices for teaching as well as learning.

Situated reflective practice

It is within the context of the classroom that teachers apply teaching strategies and processes informed by their knowledge and understanding of suitable processes and models. However it is the experienced teacher who is capable of applying a phenomenological, problem solving approach to teaching, rather that a normative approach. Experienced, knowledgeable teachers construct a modified view of their teaching world and act in ways that are consistent within this modified world (Smith and Lovatt 2003: 140). This modified world is contextual and dependent on the constraints of the education system, all stakeholders and the knowledge, skills, experiences and understandings of the teachers themselves.

Research suggests that self-efficacy and teacher self-concepts are the driving factors in decision making and problem solving in teaching practice (Smith 1983). A sustained, critical, self-reflective approach to analyze one's teaching within the environment of the school, and the ability to locate one's own actions within a wider (macrocosm) socio-political and cultural-historical context are the characteristics of teachers who are able to continuously decide what to teach, how to teach it, how to respond thoughtfully and constructively to the learners in their class, and how to engage with their professional colleagues, parents and institutions in the broader community. Teachers who can make accurate decisions quickly and efficiently, as well as making decisions based on carefully researched and assembled evidence, shape and frame what lies at the very heart of teaching and learning (Groundwater-Smith and Mockler 2003: IV)

Carter and Halsall (1998) identify the following essential characteristics of practitioner research:

- It is grounded in data, which has been systematically collected and analysed for a clearly defined purpose.
- It is undertaken by teachers, though sometimes with the support of external critical friends.
- It focuses on professional activity, usually in the workplace itself.
- It has the purpose of clarifying aspects of that activity with a view of bringing about beneficial change, ultimately to improve student progress, achievement and development.
- It may focus on both teaching and learning at classroom level, and supporting organizational conditions and change management capacity
  (Carter and Halsall 1998: 73)

A reflective practitioner is a 'researching' teacher

When applying a Habermasian view of unifying theory and practice as integral components of a democratic curriculum that encourages the learner to become autonomous, it becomes evident that in order to become an excellent teacher it is important to become a 'researching teacher' who conducts ongoing, critical research into own practice. Ruddock (1985) argued that the primary benefit of research in teaching is the sharpening of professional curiosity and insight (Ruddock quoted in Smith & Lovatt 2003: 136). *Reflection in action* (present) allows teachers to review, reconsider and re-evaluate a situation immediately within the context of time and place. Alternatively, *Reflection on action* (past) allows for teachers to further research and critically assess and evaluate their own practice. Both facilitate intervention, in other words both situations permit for the development and implementation of better-informed teaching strategies.

High levels of reflection in education lead to curricula, which continuously provides critique of institutions, authority and own practice. At this level of critical scrutiny, embedding Habermas and hermeneutic knowing, education becomes genuinely human, and, presumably ethical, marked by justice, equality and freedom (Smith and Lovatt 2003: 105).

In order to critically evaluate professionalism, performance and empowerment of the individual that positively affect professional development, a conceptual framework that allows a teacher to explore and reflect on their own practice, to develop deeper understanding and facilitate improvement can be found in the processes employed in design and technology education.

A proposed methodology

Investigating one's own teaching engages the teacher into an internal dialogue that illuminates and clarifies day-to-day challenges in the teaching profession that inform their classroom conduct and response to teaching experience. Using a design and technology education approach provides a conceptual framework to analyze and evaluate these experiences, to recognize and articulate various issues, to consider

Comparitive Table	
Practitioner research	**Design and technology education**
The aim of practitioner research is for teachers to develop confidence, competence and responsibility in critically reflecting, analysing and evaluating own teaching and to understand the factors that contribute to successful teaching	The aim of design and technology education in NSW schools is to develop students' confidence, competence and responsibility in designing, producing and evaluating to meet both needs and opportunities, and to understand the factors that contribute to successful design and production
The objective of practitioner research is to develop knowledge, understanding and appreciation of: • Teaching and learning processes in a range of education contexts • The interrelationship of teaching and learning in a range of education contexts • Reflective action, critical analysis and evaluation of own practice in a range of education contexts • The application of critical reflection to develop and implement quality measures to improve future practice in order to enhance teaching and learning	The objective of design and technology education in NSW schools is to develop knowledge, understanding and appreciation of: • design theory and design processes in a range of contexts • The interrelationship of design, technology, society and the environment • Creativity and an understanding of innovation and entrepreneurial activity in a range of contexts • The application of design processes to design, produce and evaluate quality outcomes that satisfy identified needs and opportunities
A methodology applicable to engage in practitioner research includes: • Identifying, analysing and evaluating needs and opportunities for new and improved practice • Recognising, analysing and evaluating needs of students and stakeholders in education contexts • Critically reflect, analyse and evaluate own practice in context • Research and explore possible teaching and learning solutions • Develop and evaluate innovative, creative and appropriate teaching and learning solutions • Select and implement appropriate and achievable teaching strategies • Select and use a range of activities in the development and implementation of new and improved teaching practice • Develop and implement activities and strategies to allow for ongoing evaluation of new and improved teaching practice	A methodology applicable to engage in design and technology includes: • Identifying, analysing and evaluating needs and opportunities for new and better solutions • Recognising, analysing and evaluating needs of end users and other stakeholders in contexts • Critically reflect, analyse and evaluate existing design ideas and solutions in context • Research and explore possible design solutions • Develop and evaluate innovative, creative and appropriate design solutions • Select and implement appropriate and achievable management strategies • Select and use a range of technologies in the development and implementation of new and improved design solutions • Develop and implement activities and strategies to allow for ongoing evaluation of new and improved teaching practice

a range of solutions, to develop strategies for implementation and to evaluate the outcome. A teacher familiar with design and technology principles will be accustomed with these approaches. Using this conceptual framework offers a cognitive structure that can provide for new, appropriate teaching practices to be developed and implemented.

In assisting the research process, I propose the usage of methods and procedures commonly implemented in design and technology education. Embedded within the New South Wales (Australia) Design and Technology curricula are design processes that foster the negotiation of meaning through application of critical reflective problem solving strategies (Grushka 2004: 20).

This reflective practice involves analyzing the function of designing for its cultural, sociological, phenomenological and ethical praxis dimensions. When the practices of designing are considered within the contexts of time and space a genuine inclusive enquiry emerges.

Within the context of design and technology education critical reflection is a core strategy that facilitates awareness of the relationship between the strands commonly employed in this learning area: 'investigating, designing and making, and evaluating'. Furthermore, the NSW Board of Studies asserts that 'processes employed in design and technology education develop student's competence, confidence and responsibility in their interactions with [science and] technology, leading to an enriched view of themselves, society, the environment and the future, which will enable them to develop positive and informed values and attitudes towards themselves and others' (Board and Studies

1991: 105). It is my belief that these criteria are also essential for improving one's own teaching practice.

A simple comparison between essential criteria of practitioner research and the processes applied in design and technology education reveals commonality of aims, objectives and methodology. Below is a comparative table; the information in column on the right is taken from the current NSW 7-10 Technology Syllabus (2003:21-25), whilst I developed the column on the left in response to the aims and objectives of practitioner research. The final section of the table explains the proposed methodology as developed by the NSW Board of Studies on the right. On the left is my proposed conceptual framework that can be applied when engaged in practitioner research.

From the above table it is clear that a process, or method proposed in current NSW technology education curricula can easily be transposed and used as a conceptual framework to investigate one's own practice. However it is imperative to understand that learning to critically assess and evaluate own practice, to develop and implement change, is not simply a matter of learning new techniques. It also requires change in underlying values and assumptions that have structured one's theory of practice (see for instance: Schön 1983; Schön 1987; Schön 1991).

Conclusion

In this paper I have introduced aspects of practitioner research and argued its value in the context of teacher professional development. Aware of the fact that the concepts of research could impose problems for novice teachers or those unfamiliar with research per se, I have introduced a methodology commonly used by students in design and technology education to be considered as a conceptual framework to commence practitioner research in the context of the classroom. This framework will assist teachers' threefold: in the first instance it demystifies a research process and makes it accessible to teachers with varying degrees of research experience; secondly this methodology will assist teachers in understanding their current practice in a a simple and straightforward manner; thirdly it open a way for teachers to use the gathered information as a basis for professional development. It would be most satisfying to see the model applied within the context of improving teaching practice in design and technology education, considering it has been generated by the very process that is inherent in design and technology education. In this paper I have demonstrated that practitioner research will facilitate greater understanding as interpreting one's own practice in situ enables a deeper level of learning to take place. The development of this contextual 'knowing' offers a heightened understanding of practice, informed by self and the very nature of the problem. Analysis and interpretation of own practice in an objective manner generates hermeneutical ways of knowing which in turn allows for negotiation of meaning through transformation (see Smith and Lovatt 2003; Grushka 2004; Sachs 1999 and Schön 1983-1991).

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Pupils' Views of Writing Tasks in Design and Technology: Purposeful Activity or Just More Paperwork?

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Abstract

Tasks which involve children in writing, often combined with drawing, have become an established part of design and technology practice in England at Key Stage 2 (pupils aged 7-11). These serve a variety of purposes from the teacher's perspective. However, what meaning do pupils make of them? Do they view them as purposeful and integral elements of their design and technology experience or do they regard them as unwelcome intrusions into the enjoyable business of designing and making?

There has been a significant increase in the level of interest in pupil perspectives in both school improvement and education research over the last decade. This paper draws upon this recent work in order to make public the very particular insights that children can offer to help us increase our understanding of the complexities of teaching and learning in design and technology.

This paper is based on an analysis of interviews with 35 pairs of children aged 9-11, from mixed age classes in three rural schools. This data was gathered as part of a larger collaborative action-research project.

Introduction

Over the last decade, primary teachers in England have been encouraged to incorporate elements of literacy in design and technology by both government-funded education bodies (e.g. SCAA, 1997) and design and technology professional associations (e.g. DATA, 1999, NAAIDT, 1999). This reflects the concern of government policy to improve the standards achieved by pupils in writing, and the concern of the professional design and technology community to promote design and technology as a motivating context for broader learning. Stables et al (2000), in their evaluative study of the impact of a curriculum development project, found that design and technology can be successful in developing some literacy skills and some design and technology skills through a programme of structured activities. However, the same study also showed that the Year 6 children experienced 'unfortunate levels of disengagement' when the literacy tasks were arduous or repetitive, or where the children were required to 'hoop-jump' by following a tightly controlled, linear design process. Other research studies outside design and technology have found that writing is a major concern for pupils and is generally disliked (Sheeran and Barnes, 1991; Pollard et al, 2000). It would seem that the successful combining of literacy and design and technology objectives in design and technology lessons is more complex than is sometimes acknowledged.

In my research I have set out to investigate writing tasks as an element of design and technology practice from the differing perspectives of teachers and children. In an earlier stage of my research, I identified a typology of purposes for writing tasks in design and technology which meet a variety of educational, management and accountability needs from a teacher perspective (Mantell, 2003). In this paper, I present findings related to children's perspectives of writing tasks. How do pupils regard writing tasks from their perspective of learning and participating in design and technology? Are they helpful or unhelpful? Pupil perspectives often highlight the differences between the intended and unintended curriculum, between what policy makers and teachers focus on when considering the planning and delivery of curriculum tasks, and what pupils experience when engaged in such tasks (Pollard et al, 1997).

Methodology

The findings presented here are derived from data collected as baseline data in the early stages of a larger action-research based collaborative study between myself and three teachers and their mixed age classes (9-11 year olds) in three small rural primary schools. Data were collected through interviews with 71 children: 34 pairs and 1 group of 3. Paired interviews were used rather than individual questionnaires to enable discussion between the children and a deeper probing of pupil perceptions. At this stage of the research, the children were asked about their views of design and technology and their views of writing tasks in design and technology in general terms, rather than their views of a specific unit of work. The data used as the basis for this paper were generated by the questions: Why do you think your teacher asks you to do this writing in design and technology? Is the writing helpful or unhelpful? In what way is it helpful/unhelpful? The data were coded and analysed using the constant comparative method.

In my research I am using the term 'writing task' to refer to any activity initiated by the teacher that requires pupils to write. In design and technology, children often use writing in conjunction with other forms of expression, such as discussion, drawing and working with materials. The texts they produce are usually short and take a variety of forms such as lists, notes in a table, annotated drawings, plans and mindmaps.

Findings

The majority of children in this study regarded the writing tasks they experienced as helpful to them in design and technology.

Is the writing you do in design and technology helpful or unhelpful?	
Helpful	55
Unhelpful	1
Both helpful and unhelpful	15

There was a marked difference of response between the three schools. In two of the schools, there was only one pupil in each for whom writing tasks were not straightforwardly helpful. In the third school, the children were more evenly divided between 'helpful' and 'both helpful and unhelpful' (19:14).

The majority of pupils were able to suggest why writing tasks were helpful to them, often giving a cluster of reasons. Their responses have been coded (multi-coded where necessary) and assigned to 5 categories derived from the data, presented here in rank order with the most frequently cited reason first.

Reasons given by pupils why writing tasks were helpful to them in D&T
Creates a record we can refer to
Helps us to plan and make our product
Helps us to learn and understand
Prepares us for the future
Helps us to improve our writing

A description of each category is given below. Interpretation, and therefore an inevitable degree of distortion, is implicit in the research process. I have chosen to include a small representative sample of pupil responses in each category to give a more genuine flavour of the pupils' voices.

Creates a record we can refer to

This category concerns two of the special characteristics that writing has in contrast to speaking: the visual nature of writing that allows us to see our thoughts on paper, and the permanence of writing: we can capture our thoughts at a particular moment in time and refer back to them later. Over half the children made responses attributable to this category.

The majority of children, who made reference to this category, used it in relation to having a plan which would help them to make their product. According to the children, having a plan reminded them of what to do and helped them to remember details such as measurements, particularly when design and technology lessons were spread out over a period of time.

> *'You need a plan to follow so you can get on with it.'* Jon

> *'If you're doing it over a long time, you can check you're doing it right and you're not going off track.'* Rybeka

A small minority of children referred to 'looking back' at their work to evaluate or make changes as being helpful. This category was much more frequently mentioned when pupils were suggesting why their teachers had asked them to do writing in design and technology. It was as if the children recognised evaluation and modification as important to their teachers, but not as an element of design and technology which they valued themselves to the same extent.

Some children recognised the benefits of having a more lasting record of their work which they could refer back to over a longer time period.

> *'I can make stuff at home using my writing.'* Natasha

> *'You can look back if doing a similar experiment and see if it's changed.'* Bethany

Helps us to plan and make our product

When children talked about their writing helping them to plan, many referred to the process of planning being helpful while others talked of the benefits of having a plan to 'tell you what to do'. The latter responses have already been discussed in the category above. This section concerns the process of planning which many pupils found helpful in sorting out their thoughts and deciding what they were going to do. This category encompasses all the design activity which might occur before children make their final product. Interestingly, 'designing' was a word rarely used by the children. 'Planning' was the catch-all word used to describe the preparation to making, and it was widely acknowledged that this writing could enhance their ability to be more organised or to avoid problems or mistakes while making.

> *'It works it all out and then you know what to do.'* David

> *'If you go straight into it, you're more likely to get something wrong and have to do it again.'* Sam

Although planning was acknowledged as helpful by the children, there were also frustrations – for some pupils although they thought it necessary, it postponed the pleasure of making.

> *'It helps you to know what you're doing but it sometimes makes you impatient because you want to do it.'* Sarah

Helps us to learn and understand

Over a quarter of the children acknowledged that writing for them was useful in their learning process in design and technology. It helped them to learn new things, such as technical vocabulary and how to make things, and helped them to increase their understanding through reflection.

> *'It improves our knowledge.'* Gareth

> *'You learn more faster'.* Ashleigh

'You know how to make things proper.' Elliot

'Sometimes it helps you understand why you did that.' Amy

This category was particularly linked to memory, the facility that writing can have in helping us to remember through the physical act of writing.

'So we remember it … it goes into your head.' Sean

'You can hold on to things, keep it in your brain.' Ben

Prepares us for the future

There were only a small number of pupil responses to this specific question included in this category. However, it is interesting to note from other data in the broader study that many of these Year 5 and 6 pupils were thinking a lot about their future – they were thinking ahead to their life at secondary school, at college and had an awareness of possible jobs and their role as parents. Many perceived the rationale for learning design and technology as being about preparing them for their future.

'You will know more at high school, you will know what to do in D&T when you get there.' Alex

'You can get on with what you are going to be doing when you are older – if you were going to be a builder you have to do a lot of writing as well.' Ben

Helps us to improve our writing

Developing specific literacy objectives through design and technology was not a prominent feature of the work in these schools. Only 2 children suggested this category as a reason why writing was helpful to them in design and technology. This was a small response in comparison to the number of pupils who gave it as a reason why they thought their teachers had asked them to do writing in design and technology.

Characteristics of writing perceived as unhelpful

Analysis of the children's interviews also provided an insight into some of the characteristics of writing tasks which these pupils found unhelpful. The pupils classed 'writing you don't go back to' as unhelpful and cited examples of writing which stayed in the teacher's desk or writing they never looked at again. This corresponds in negative form to the most frequently cited category for helpful writing: 'creates a record you can refer to'. It would appear that for these pupils, using their own texts is an important criterion for 'helpful' writing tasks in design and technology.

Examples of unnecessary and inauthentic writing were discussed by some of the children. Unnecessary writing included examples such as 'writing things down when you can remember them anyway'; and 'the fact sheets – we didn't really need them, we just had to write them'. Writing regarded as pretend, with no genuine audience or purpose, was regarded as unhelpful, for example, 'writing a list of materials you want to use when there isn't really any choice'. Writing that is difficult or too long was given as an example by a small minority of children, with a greater number mentioning forms of writing they regarded as inappropriate to design and technology, such as paragraphs. Brainstorms, note-taking and plans were all considered more favourably and were considered fun by some pupils. Writing after making, as in a final evaluation, was regarded as unhelpful by some pupils as, in their view, it did not help them to make their product. For these children (and many others), successful completion of a particular product was the sole purpose of design and technology and therefore 'helpful' writing tasks were ones which enabled them to achieve that.

Discussion

In these three schools, the vast majority of children appeared to regard writing tasks as an integral element of their design and technology experience rather than as an extension of literacy. The typical writing tasks experienced by these children support that view, in that they were closely related to preparing children to make their product. These speculative and formative kinds of writing are used to shape thoughts, note ideas, reflect and plan and are often given less value in the classroom (Bearne, 1998). They contrast with the objectives for writing for this 9-11 age group from the National Literacy Strategy (DFES, 1998), which emphasise extended writing and continuous prose.

Many of the pupils in this study considered that improving their writing might be the reason why teachers asked them to write in design and technology, although this was not as highly valued by the children. Improving their writing for many children related to the mechanics of writing, such as handwriting and improving the speed of their writing. There were very few children who mentioned particular genres of writing which might have special relevance in design and technology, e.g. specifications, design criteria, annotated drawings. There was also an apparent lack of explicit awareness of designing skills and the role which some forms of writing might play in designing.

Throughout this research study, I became increasingly aware of the time pressure that these pupils felt in relation to their design and technology lessons. Design and technology was universally popular with these children and what they valued most was the opportunity to work with tools and materials to create a product. This, for many of the children, was a welcome contrast to other subjects and they valued design and technology for its difference.

When time was at a premium, writing tasks were seen more negatively as a threat, using up precious time which could be spent making. In addition, the pupils tended to regard writing tasks which they were unable to complete due to time constraints as less helpful. When making judgements about writing tasks in design and technology, pupils are likely to take more into account than just the merits of any particular writing task alone. They are likely to be influenced by other factors such as the time available overall, the timing of the writing, the balance of activity in a unit of work, their ability in writing and their experience of other subjects.

Conclusion

In the schools in this study, the majority of pupils regarded most writing tasks as purposeful rather than as unnecessary paperwork. Most pupils regarded writing tasks which were directly related to the designing and making of their product as helpful to them, providing the balance between writing and the other activities of design and technology, especially making, was maintained. Some pupils were also able to identify characteristics of unhelpful writing tasks. There was little explicit awareness of designing skills.

These pupils' responses from an early stage of this research study provide insights into some of the patterns of children's thinking on this topic and highlight some of the complexity involved in planning successful writing tasks in design and technology. Later stages of this study will provide greater detail about pupil perceptions of specific writing tasks and a clearer indication of the characteristics of writing tasks which children regard as authentic elements of their experience in learning and participating in design and technology.

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A Rationale for the Inclusion of Design and Technology in Technical Teacher Education Programmes in Zimbabwe

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Introduction

Zimbabwe as a country is very much aware of the importance of a practical and technological biased education: an education that is relevant to industry and commerce and to the development of technology as a whole. It has a coherent system of producing architects, graphic artists, illustrators, environmentalists, engineers, including the industry and product related disciplines that produce textiles and furniture as evidenced by the number of universities, polytechnics, and technical colleges, which offer science and technology subjects. These are: The University of Zimbabwe, The National University of Science and Technology, Harare Polytechnic, Bulawayo Polytechnic and Chinhoyi, Belvedere, Mutare, Gweru, KweKwe and Masvingo Technical Colleges and all the vocational colleges.

Zimbabwe also encourages creativity and innovativeness by providing favourable environments for scientists and engineers. This is evidenced by the establishment of the Harare Institute of Science and Technology, and the Scientific and Industrial Research and Development Centre, both of which are aimed at providing a favourable environment for scientists and engineers to develop new technological ideas.

What Zimbabwe does not have is the contemporary system of technical teacher education that would provide teachers with the means to deepen and widen their knowledge and understanding in issues of design and technology which in turn would give them enough "experience and confidence to help these future professionals cope with the intensely difficult problems of contemporary urban environment and modern technology"[1] This is because technical teachers are ill prepared for the task of developing creative and innovative abilities in their students, so despite the existence of these institution the country has very few creative and innovative individuals to boast of. In other words there is a lack of an appropriate model for the training of technical teachers, who are the vital guarantee for the future production of a technical graduate with the "intellectual ability needed to design, to make, to distribute, to organise and to administer which modern life demands."[2]

Another problem is that Zimbabwe just like the rest of Africa also does not have a history of Design education, as is the case in developed countries. By the middle of the 20th century, countries like Britain and America already had a "small number of schools and colleges which trained professional designers by giving them a relatively long period of intense specialisation in various fields." They also had a "coherent system of producing architects and the contemporary education"[3] that went with it. The absence of such institutions has been the major reason why Africa has lagged behind in terms of technological developments. Admittedly this is a very expensive type of education, as it requires expensive infrastructure, equipment not to mention qualified human resources.

The Structure of Technical Teacher Education

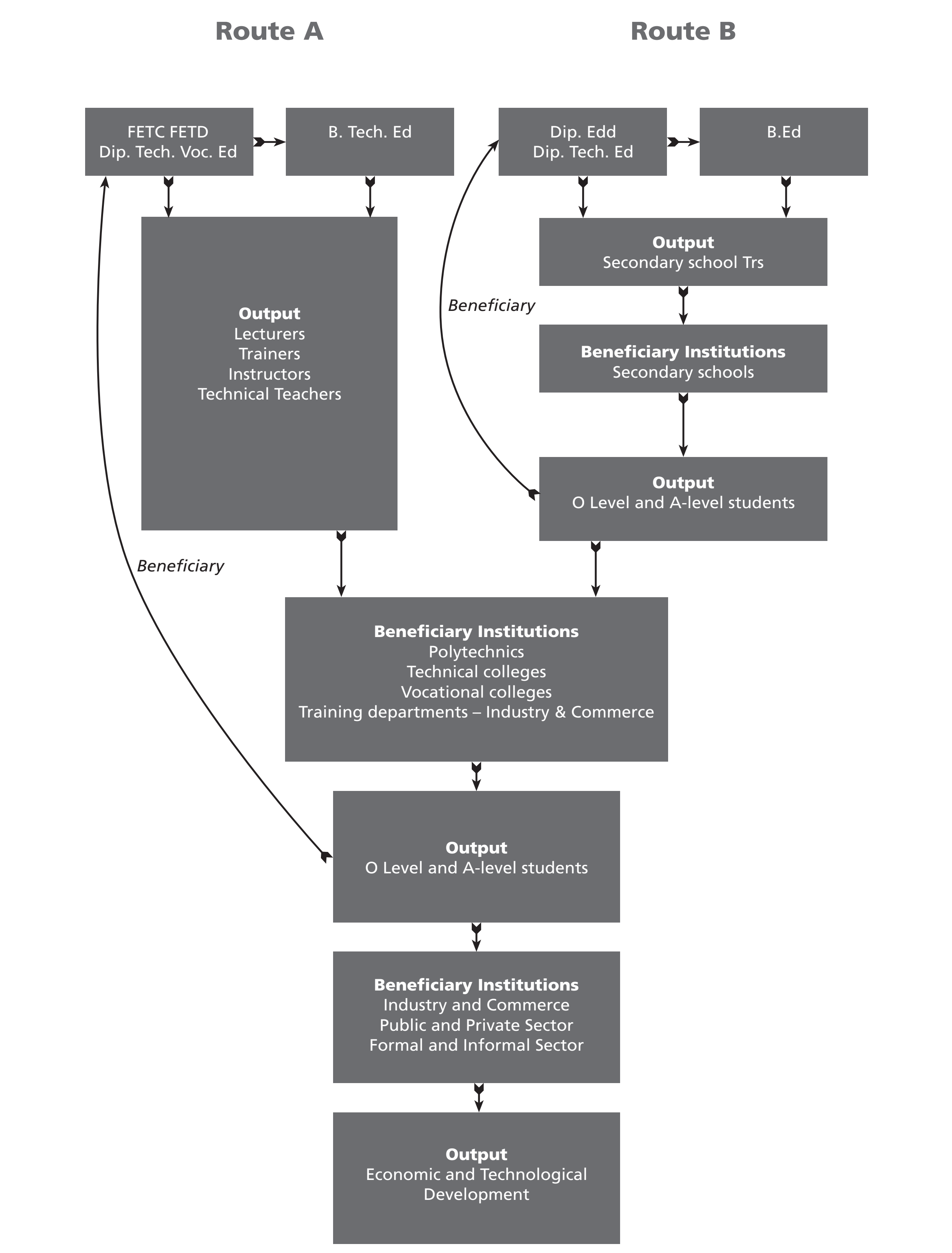
There are generally two routes for technical teacher education in Zimbabwe. There is technical teacher training for secondary school teachers which we shall call, route A and technical teacher training for polytechnics, technical and vocational college lecturers and for industry and commerce instructors and training officers which we shall call, route B. (see figure 1, over)

The target group for route B are O and A-level science and technical students who are trained in specialist technical teacher's training colleges like Chinhoyi and Belvedere and at the end of three to four years are awarded a Diploma in Technical Education in a special area. The A-level students who opt for this route are mostly those who would have failed to qualify for entry into university. The qualified teachers mainly go to teach technical subjects in secondary schools while a few find their way into industry. Secondary TTC of general education like Mutare, Hillside, and Gweru also offer selected science, technical and mathematics subjects. At these colleges students with O-level qualifications study for three years while those with A-level qualifications study for two years.

The qualified and experienced secondary schoolteachers can further their qualification by enrolling in one of two programmes offered at the University of Zimbabwe depending their on subject area of specialisation. The Bachelor of Education Science and Mathematics degree programme is offered to experienced science and mathematics non-graduate secondary school teachers. Subjects offered through this programme are: Biology, Chemistry, Geography, Mathematics and Physics. The Bachelor of Education Technical degree programme is for qualified and experienced non-graduate secondary school teachers of practical, technical and vocational subjects. Subjects offered are: Agriculture, Building Technology and Design, Home Economics, Metal Technology and Design, Technical Graphics and Design, Wood Technology and Design. Both programmes are two-year full time programmes and prepare graduates to teach in TTC. Those that cannot be absorbed in TTC go back to teach in the secondary school system. In both programmes there are four course components i.e. theory of education, professional studies, subject upgrading and teaching practice with subject upgrading taking the bulk of the time.

The entry qualifications of the target group for route A, which is the focus of this paper, range from Diploma (Dip), National Diploma (ND) to Higher National Diploma (HND) in engineering,

Figure 1: The Structure of TTE



art and design, science, commercial and other technical subjects. The programmes mainly admit candidates who are already employed as lecturers in polytechnics, vocational and technical colleges or as instructors/trainers in industry and commerce. At the moment there are three programmes on offer for this route. There is the Further Education Teachers Certificate (FETC) whose duration is one year and is meant for those without any initial teacher training experience. The Further Education Teachers Diploma (FETD), a two-year programme, is for holders of recognised initial teacher training qualifications like FETC or equivalent. These two programmes are offered at almost all the polytechnics and technical colleges except at Gweru Technical College where they offer a Diploma In Technical and Vocational Education (Dip, Tech. Voc). The Dip. Tech Voc Ed like FETC is for those with no initial teacher training. All the programmes are part time and both curricula consist of the theory and practice of education courses only. It must be pointed out that it is not a requirement to have a teaching qualification in order to teach in technical and vocational colleges. However those that obtain it have their salaries raised by a notch as an incentive.

Recently, in year 2000 the National University of Science and Technology (NUST) introduced a BTTE degree programme. The target group is those technical lecturers with no initial teacher training experience just like the FETC and Dip.Tech.Voc programmes. Holders of diplomas in education are exempted from the first year of the programme. After graduating the lecturers go back to teach in technical colleges or training institutions in industry and commerce. The programme offers theory of education courses and subject upgrading courses. However subject upgrading amounts to subject enrichment because due to the wide variety of subject specialisms of the students, subjects were grouped so that the courses are not specific to any one subject but consisted of common courses to each group of subjects.

It is very clear from what I have discussed above that the experience that technical student teachers have in the (FETC, FETD, Dip.Tech.Voc.Ed, and even the B.Tech.Ed programmes at NUST), is full of shortcomings as a full and effective education for technical teachers. One can see that there is very little difference between the course components offered through these programmes and those offered in the general Teacher Education programmes. In fact the general education programmes are more valid because they include the professional studies component where the learner tutor is equipped with the necessary and relevant skills that will enable him/her to guide his/her student teachers to be professional teachers. As mentioned earlier on, the FETC, FETD and Dip. Tech Voc. programmes offer theory of education courses only and the subject enrichment component is left out while the professional studies component is completely ignored. In the case of the NUST programme subject enrichment mainly involves the learning of facts and information and the tracing of the rapid changes of designs and technology developed in other countries mainly Europe, Asia and America. It also emphasises the acquisition of skills in using instruments and knowledge of often outdated machine parts.

This kind of scenario is cause for concern as it is a clear indication that not much thought being put into the structure and content of its TTE programmes. The introduction of D&T through PS would also give the TTE programmes more visibility, credibility and intellectual weight as it demands more thought, creativity and innovativeness. Surely there should be much more to Technical Teacher Education than merely equipping teachers with basic teaching skills and learning facts, information and how to operate and use technology developed elsewhere. Engineers, scientists and artists need to be design/technologically literate and capable. Here I am not talking of the so called 'design projects' that are presently given to students which are superficial in that they are the answer to an imagined problem and are without context. No wonder the lack of a credible programme for TTE has resulted in resistance by lecturers in science and technology universities to undergo teacher training. The narrowness in scope and depth of these programmes leaves a lot to be desired and is the reason why most of these graduates feel they are a waste of time and from the point of view of this paper their attitude is understandable. Another reason why this paper is advocating for the introducing D&T in TTE programmes first is because starting with the training of teachers, means that there will be people with the pedagogical ability to design D&T programmes for other levels of technical education. This is bearing in mind that "no reform in education will succeed without the co-operation and support of teachers"[4]

The poor training of technical students in Zimbabwe is consumerist oriented and creates a dependency syndrome in students because the teachers themselves are not well equipped to develop problem-solving skills in their students. TE produces employees rather than employers and producers thus its products fail to make a meaningful input in the technological oriented world of today. In other words it produces people who are not capable of binging change within their communities.

The present technical education results in for an example the production of a technical engineer instead of a design engineer, a technical scientist rather than a design scientist, a technical architect instead of a design architect etc. This implies that the person is only able to operate and service machinery designed and developed in other countries or to duplicate, copycat or produce gimmicks of designs designed and developed elsewhere. The individual is unable to look at the environment with a critical eye – meaning that he is unable to develop new ideas in his field and neither can he/she improve any aspect of technology in terms of design, function, performance, material or even appearance. While technicians are valuable to an extent they are only useful as employees or if they start their own businesses it will only be as service providers.

There is a lot of talent lying untapped and the absence of the right kind approach to TE represents a continuing massive waste of latent talent, in the sense that what is not husbanded and harvested is wasted. It is important to note that the few people who have come up with innovative designs in Zimbabwe are not 'made' but happen to be creative by nature i.e. they are geniuses. When interviewed, most if not all of the inventors, attribute very little or nothing to formal education. A good example that comes to mind is that of Mr Daniel Chingoma the founder of Taisek Engineering who designed and developed an innovative water pump for rural areas. In an interview with Farai Gonzo on AM Zimbabwe on 9th June 2001 from 7.30 to 8.00 he was asked how he came to be creative and innovative. His answer was simply that it was an inborn talent. Another example is that of young boy (Vusumuzi) also interviewed on ZBC news on the 31-07-01 in connection with a gun that he had manufactured using scrap metal. When asked to what he attributed his creativity, he said that he got his ideas from his dreams. There are many more such examples that testify to the uselessness of the present system of education in Zimbabwe in terms of developing creative and innovative abilities.

The dilemma of the technical teacher is that he, unlike the trainee tutor in general education, who is trained to teach students how to also teach albeit at a lower level the TT is being trained to teach students who end up in industry and commerce in both the private and public sectors. His is also expected to train his students for entrepreneurship i.e. they must be creative and innovative individuals who do not only consume knowledge but also use it for economic development. This is because the economic situation in Zimbabwe as in many other countries is increasingly making job security a thing of the past. So leaving out the PS component in my view is criminal to say the least because it amounts to the production of a partially trained TT who is not fully equipped to guide students for the roles they are supposed to play in society. Thus the introduction of the PS component is a necessary development because it is through it that D&T courses can be taught since the nature of D&T is such that it acts as a 'bridging subject' for all technical subjects. It "involves inter subject teaching which requires teachers to have a broad base of knowledge" and it therefore makes sense that teachers be "trained so that they acquire the additional knowledge needed to broaden their base."[5]

Conclusion

Technical teacher education in Zimbabwe today is in "ferment and changes have to be made"[6] There is need for an effective D & T programme for technical teachers – a programme whose impact would permeate into industry, commerce and to all levels of TE in Zimbabwe. TE in Zimbabwe should aim at producing an engineer, scientist, and artist who is both technician and designer/technologist. Emphasis should now shift to educating specialists who by their expertise in research, design, development and the use of new techniques, can rapidly increase wealth. It is in this group that shortage of manpower lies. To make good Zimbabwe has to reform its technical education system so as to make it possible to equip these professionals with skills to address and solve environmental problems. There is need for a body of theoretical and practical knowledge, which will address this problem and there is no doubt that a curriculum with D&T education at its core produces a high calibre of students who are "motivated to stretch their intellectual powers, use their imagination, co-ordinate their studies and foster their skills in an atmosphere of contemporary realism."[7]

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Teachers' Perceptions of the Purpose and Practice of Design and Technology Education

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> *The teaching of design and evaluation remains weaker overall than the teaching of making.* (Ofsted, 2004)

Abstract

This research project focused on teachers' perceptions of the purpose and practice of design and technology education. In doing so it addresses the question: what is it that teachers value in design and technological activity? Is it just the making activities or are other aspects considered?

Introduction

Design and technology has only been a significant subject in schools in England since the introduction of the National Curriculum by the Department for Education and Science (DES, 1990) and has continued to develop with different versions (DES, 1995) and, most recently, the current version jointly produced by the Department for Education and Employment (DfEE) and the Qualifications and Assessment Authority (QCA, 1999). Many primary teachers, who are involved in teaching the subject, have had limited formal training or professional development related to design and technology. With this in mind, their understanding of the subject and its role in pupils' education is an interesting area to study.

Design and technology capability involves the acquisition of specific skills and knowledge along with the development of process skills such as decision making and evaluating. In order to develop this capability, teachers need to organise learning opportunities that both develop pupils skills and provide opportunities for thinking and decision making. The hypothesis at the beginning of the study was that primary teachers have a limited understanding of design processes and tend to value focused activities that develop craft skills but fail to develop pupils' ability to take risks and tackle new (technological) problems. This is supported, to some extent, by national subject reports produced by (Ofsted, 2004).

This study sets out to explore this hypothesis by addressing a number of key questions including:

- What is the purpose and value of undertaking design and making activities with pupils?
- What do children learn through design and technological activity?
- What kinds of teaching and learning activities do teachers organise / facilitate?
- Which kind of activities do teachers feel are the most valuable? For what reason?
- How are teachers' views of design and technology education linked to their understanding of design processes and technology in general?

At its best, design and technology is a creative and challenging subject that places significant demands on teachers. It requires an in-depth understanding of the processes of designing along with sound knowledge of tools, materials and processes.

It is for these reason that the Design and Technology Association (DATA) produced both Help Sheets (DATA, 2000a) and Lesson Plans (DATA, 2000b) to support all of the QCA Units of work (QCA, 1998). These documents present a very specific and structured pedagogical approach to the subject.

The extent to which teachers interpret the Schemes of Work and associated paperwork, relies on their understanding of the purposes and practice of the subject, combining what (Banks et al., 1999) refer to as school knowledge, subject knowledge and pedagogic knowledge. Consequently the views held by teachers are crucial in determining the kinds of activities in which pupils are engaged and the overall quality of their design and technology education.

Literature review

Design and technology is a relatively new subject and as such there is a limited amount of literature available. The subject specific literature that has been written is usually published in the *Journal of Design and Technology,* the *International Journal of Technology Education* or in conference proceedings. In addition there are a number of edited and single author books which are available. For the purposes of the review, both the above journals were explored as well as conference papers since 1990, when design and technology became a National Curriculum subject. Relevant published books were also reviewed.

The most important theory or concept relevant to the study was that of technological capability or technological literacy. This has been explored in many countries, such as New Zealand, South Africa and the United States, and there is general agreement that the development of capability involves both the acquisition of craft skills and knowledge as well as thinking and decision making during the processes of designing and making.

Internationally there is a good deal of literature available on the concept of technological capability, most notably the Standards for Technological Literacy from the United States (ITEA, 2002) and the New Zealand Technology Curriculum (Ministry of (Education, 1995) which provide a good insight into the concept and identify skills, knowledge and understanding that pupils should have at different ages.

In England the design and technology curriculum is prefaced by a statement outlining the unique contribution that the subject makes to pupils' general education.

> *Design and technology prepares pupils to participate in tomorrow's rapidly changing technologies. They learn to think and intervene creatively to improve quality of life. The subject calls for pupils to become autonomous and creative problem solvers, as individuals and members of a team. They must look for needs, wants and opportunities and respond to them by developing a range of ideas and making products and systems. They combine practical skills with an understanding of aesthetics, social and environmental issues, function and industrial practices. As they do so, they reflect on and evaluate present and past design and technology, its uses and effects. Through design and technology, all pupils can become discriminating and informed users of products, and become innovators.* QCA (1999)

This provides a current statement of technological literacy related to the National Curriculum. Links between this and the QCA Scheme of Work are not explicit in documentation, making it the job of teachers to integrate the broader aspects into day-to-day teaching.

In addition to technological literacy, the notion of design and technology teachers being reflective practitioners is also significant. There is, however, little literature on this, with that produced by Banks et al (1999) being the most significant. They present a model, mentioned above, where an understanding of pedagogic knowledge is as important as subject knowledge in developing what they call an overall personal subject construct.

The curriculum documents produced in different countries all use specialist language and assume that teachers understand the processes of designing and making. The terminology used is not usually explained. Consequently the interpretation by teachers may vary according to their understanding of design and technology in general terms and their knowledge of specific technical vocabulary.

As for the work on reflective practitioners, this has concentrated on developing a theoretical model for teachers' personal subject construct. It does not provide examples of the construct in any depth or explore the practice of teachers who do not have much understanding of the pedagogy of designing and making and the subject knowledge to go with it. Consequently, there would appear to be a gap in the research.

The potential discontinuity between the specified and enacted curriculum has not been (explicitly) the subject of research in journals or conferences on design and technology in the UK, yet remains an important factor in the development of the subject in schools. It has, however been the topic of research in other curriculum areas. Articles on teachers response to policy change such as that written by Gallucci, (2003), are particularly useful. In addition there are a number of existing research instruments to assess teachers classroom practices and the enacted curriculum such as the online survey produced by the Wisconsin Center for Educational Research (WCER, 2004).

The study attempted to reveal such understanding of the subject in terms of its purpose and practice and therefore provide a unique insight into the interpretation of the prescribed curriculum by teachers in the classroom.

Methodology

As the focus was on finding out about teachers' attitudes and perceptions in some depth, a methodology that was qualitative in nature seemed appropriate. There are a variety of different approaches to qualitative research but all result in a small amount of rich data from often very specific contexts.

A qualitative, ethnographic, approach was adopted as I was concerned with what Garfinkel (1967) called *'practical activities, practical circumstances, and practical sociological reasoning'* as topics of study. The study of perceptions would indeed be difficult to categorise and quantify and it is likely, if an alternative quantitative approach were adopted, that some important data, may not be gathered as it did not fit into a particular category.

It is, however, because of the very nature of this type of enquiry that critics suggest that qualitative approaches are open to bias. (Phillips, 2003) for example suggests that qualitative researchers are likely to misjudge the frequency rate of certain behaviours. Whilst this is important to recognize, it will be the nature of the behaviour itself that is likely to be of interest. He further suggests that researchers may be unduly influenced by positive instances, be not so sensitive to the significance of negative instances and be influenced by experiences early in the research. Given my pre-conceptions about teachers' knowledge, bias would clearly be an important consideration.

The ability to change and modify the approach to observation and data collection is an important feature of a qualitative approach and enables more precision and refinement in looking at a particular context as Cohen et al., (2000) suggests. In addition it allows the development of theory direct from practice which, in the absence of any existing theory in current literature, was well suited to the project. Such *grounded theory* as described by (Glaser and Strauss, 1967) would certainly be useful in informing curriculum development in the future so that the prescribed curriculum might be interpreted more accurately.

Often, in education qualitative research involves the exploration of a single institution with a very specific social contextual framework. A perceived weakness of this is that it makes it difficult to generalize any outcomes that might prove useful to other educators. Rather it presents a story of one particular enquiry in one particular environment through the eyes of the researcher.

Qualitative enquiry, undertaken by an individual or a small group of people, in this way is open to individual bias, and make it, some would argue, subjective in nature rather than objective. Kerlinger, (1969) suggests that all methods of research, particularly observation, have some degree of objectivity. The key is in the approach taken by the researcher. In other words it is a researcher's job to maximise the degree of objectivity in their work. (Newell, 1986) supports this view suggesting that what makes a judgement objective has more to do with people's practice than what he call 'outer objects'. It is the quality of research activity that is key.

The original hypothesis for the research was that primary teachers have a limited understanding of design processes and tend to value focused activities that develop craft skills but fail to develop pupils' ability to take risks and tackle new technological problems. In order to test this hypothesis, the generation of a number of key questions about the purpose and practice of teachers was necessary.

In interviewing teachers, it was anticipated that this would provide useful information for phrasing the questions used in order to obtain the information that will test the hypothesis.

Different types of interview have advantages and disadvantages (Patton, 1990) and it was decided to use very specific key questions and to ask them in what appeared to be a logical order. This type of open-ended interview had the advantage of reducing interviewer effects and bias whilst making the organisation and analysis of data relatively straightforward.

Data collection process

The sample was limited to a small number of teachers (four in total) in two local schools. The schools were both state primary schools in a socio-economically mixed area of Birmingham. The selection of teachers to interview aimed to cover design and technology co-ordinators as well as teachers who taught different age groups.

As access to teachers during term-time was likely to be difficult, arrangements were made to undertake all of the interviews after the schools had finished for the year.

This had the advantage of reducing potential distractions and meant that interviews could take place in staff rooms of the schools with no interruptions or distractions from other people.

Interviewees were informed of the general purpose of the research, what would happen to the data and their right to withdraw from the interview process. This ensured that the research be carried out as ethically as possible. With eight questions, the interviews lasted approximately 15 minutes each.

From the key questions outlined in the *Introduction,* four general categories emerged in relation to the purpose, and practice of the subject as well as the influences on their thinking and degree of ownership over what they taught.

Open-ended questions were used exclusively in an attempt to explore teachers experience and feelings towards the subject and its practice. For example:

> *What do you see as the purpose of undertaking designing and making activities with children?*

All teachers interviewed were able to provide responses to the open questions that were highly relevant and related to the over research hypothesis. Occasionally further prompting, and sometimes supplementary questions, were required when teachers did not answer the question directly or misinterpreted what was said.

One of the difficulties experienced during the interviews was that of keeping to the exact wording of the questions in order to increase the reliability of the data collected. This became easier with time and is likely to be of less significance if further studies are undertaken.

Initial findings

There were a number of issues that emerged from the data. Of these the most significant was the language used by teachers. When asked about the purposes of design and technology education they used design process terminology such as:

> *Thinking skills … evaluating skills …* Teacher A

and

> *Exploration, investigation … problem solving …* Teacher B

This reflects a degree of understanding beyond which I had anticipated and challenged my original hypothesis. It was also clear that the questions on purpose were appropriate to gather useful data.

No specific question on how they planned activities was asked but it became clear from their responses that those primary teachers interviewed plan collectively and their joint planning is very influential in what and how they teach.

When you have got people on the team who know a little bit more about it or its their subject they heavily influence what you do and which way you go. Teacher D

Not all teachers understood the questions. Most notably Teacher C who in response to:

Of all the kinds of activities … which do you feel are the most valuable?

asked a question in return:

What do you mean by valuable?

As a result I felt obliged to clarify what I meant by valuable and provide possible suggestions of activities that might be so. This I felt was then likely to influence his subsequent response.

Reflections

The questions used were very effective in providing an insight into how they viewed design and technology as a subject in the curriculum and the kinds of experiences they planned for children.

It became clear from looking at the transcripts that the community of practice within a school had a strong influence on what teachers did in the classroom. Three of the teachers specifically mentioned team work and all of them used the term *we* when talking about their planning. Given the degree of collective planning that does tend to take place in primary schools this was not surprising. The addition of a key question about the nature and scope of collective planning would therefore be of importance to the interview process during the project.

The data collected from the interviews was typical of that generated from qualitative research, personal and unique yet rich in nature (Cohen et al., 2000). In exploring the links between the prescribed and enacted curriculum (Alexander 1992), this was most useful as it indicated the kind of influences on teachers that might affect their overall construct of the subject.

Having used such a methodology, the original idea of developing questionnaires, that would be completed by teachers without an interview seemed inappropriate as some of the influences on teachers were hard to categorise and may not be revealed without clarification or supplementary questioning. This led to a change in the research proposal outlined below.

The interview technique adopted was effective but provided little flexibility and limited the naturalness of the questions and answers as Patton (1990) suggests.

The presence of bias is of concern in the project undertaken and in qualitative methods in general. During the data collection period in particular the notion of procedural objectivity that Eisner (2003) put forward will need to be kept very much in mind.

Another consideration was the possibility of changing the specific nature and deliberate order of the questions. On the one hand the ordering is a constraint but it does make the interviewing process consistent and increases its validity which is critical in such qualitative research (Cohen et al. 2000).

Of all of the issues that emerged from the study, the most significant is probably the importance of group planning in developing what could be called a *community of practice* (Lave and Wenger 1999) within a school. For this to happen, the design and technology co-ordinator is key.

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The Technology Fair as Mean for Promoting Primary Education Students' Problem Solving Skills and Interest in Science and Technology

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Abstract

There are many ways in which university education can help undergraduates primary education students become better problem-solver. This paper presents the idea of using the Technology Fair as a means for promoting students' problem solving skills. Specifically, we reflect upon the results of study carried out in Autumn 2004. The sample of the research consisted of 85 undergraduate students of the Department of Educational Sciences enrolled in a compulsory course on Design and Technology at the University of Cyprus. The purpose of the study was to investigate the influence of a procedure of working with primary school children to complete and present a Technology Fair project, on the problem solving skills of undergraduate students. Pre-tests and post-tests were administered to undergraduate students before and after the preparation of the Technology Fair, respectively. A number of students was selected and interviewed after the completion of the technology fair. Data also collected from reflective diaries kept by the students during the preparation of the technology fair. The analysis of the results indicates that the Technology Fair contributes to the development of positive values and attitudes in science and technology education and has a significant influence on improving students' understanding and application of problem solving and decision making strategies within the domain of technology.

Introduction

Science Fair projects have long been used as a mechanism for promoting scientific skills with an emphasis on learning through "doing". Identifying problems, formulating questions, making observations, proposing solutions, and interpreting data are necessary skills for students in school and throughout their lives. The type of education that places emphasis on these skills through hands-on science activities can simultaneously promote understanding of fundamental principles in science (Czerniak & Lumpe, 1996, Duggan & Gott, 1995).

The Technology Fair is a new idea derived from Science Fair projects that have been taking place for many years by the Learning in Science Group, University of Cyprus. Technology Fair initiatives encourage students to explore their technical environment in a systematic manner. The underlying principle is that participation in a Technology Fair stimulates students' interest in science and technology while simultaneously promoting the development of technological problem solving and decision making as important life skills. In this paper we present a preliminary study of an initiative to integrate the Technology Fair in the context of an elementary teacher preparation program.

Theoretical Background

Science and technology education share a commitment to teaching process, scientific method in science, design in

technology and problem solving in both areas. Teaching students how to solve problems is an important goal of education.

Problem solving strategies hold a special importance in education. Many tasks performed in professional and daily life require such strategies, which we define as planned sequences of activities leading to a goal which is the solution to the problem. Examples of such tasks are: writing an informative text, designing a product, solving a management problem or a technical or scientific problem. Much research has been carried out into problem solving, analyzing and describing strategies for solving different types of problems, designing instruction and/or training for chosen strategies, and measuring the result of teaching interventions (Doornekamp, 2001; Boud & Feletti, 1991).

Problem based learning is an instructional approach that has already been at least implemented on a trial basis in elementary and secondary education (Delisle, 1997). The problem acts as the stimulus and focus for student activity and learning (Boud & Feletti, 1991). Learning in this way is purposeful and self-sustaining as the student learns while searching for solutions to the problems they have formulated themselves. Students are actively involved and learn in the context in which knowledge is to be used.

First versions of teaching approaches in relation to problem solving sometimes rely heavily on practicing problem solving on a large number of problems. Instruction and feedback are usually focused on the sequence of problem solving steps to be performed and less emphasis is placed on the knowledge and the cognitive strategies necessary to perform these steps. In the 1980s, researchers introduced new methods of instruction composed of a wider variety of learning tasks. Some of these were based on new insights into cognitive processes. Many of these approaches are inspired by theories on the role of schemata in domain knowledge (Gick & Holyoak, 1983) or by theories on mental models (Chi & Bassok, 1989). Recently, more emphasis has been placed on the use of computers and modern information and communication technology (ICT) in the teaching of problem solving and on peer collaboration (e.g., Hoek, Terwel, & van den Eeden, 1997), whereas cognitive psychology has produced new perspectives such as multiple-code theories and connectionist models (Sternberg, 1999).

Thus, a wide variety of promising instructional approaches is available to teachers, instructional designers, and researchers. However, a more systematic overview of the merits of the various approaches in terms of learning outcomes achieved in experimental settings is needed as a basis for the application of new methods of instruction. (Taconis & Broekkamp, 2001).

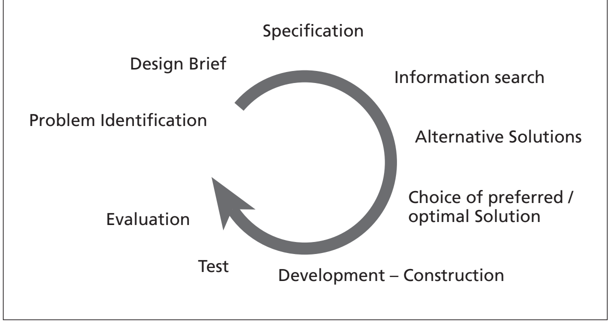
Problem solving and technological developments have much in common. Technologies have historically given solutions to many of the problems people encounter. Problem solving activities provide students with opportunities to create and evaluate designs and to experience knowledge seeking, processing, and applications.

Problem solving activities implemented in technology education expand the opportunities for students. They teach students how to think, make decisions, and apply knowledge learned from experiences in and out of school. It is important for prospective primary teachers to develop this important instructional component.

To develop problem solving skills, students, through practice, must apply problem solving and thinking techniques to solve real problems. Students must merge the content of problem solving and the content of technology and integrate technical skills and problem solving skills. Technology Fair projects provide an opportunity for interaction between undergraduate student teachers and elementary school students so that they can work as a team with shared but different goals: The child aims to solve a problem and present both the problem and the solution during the Technology Fair. The student – teacher aims to use the interaction as a medium for helping the child develop problem-solving skills through a systematic approach.

In the context of Design and Technology problem solving is generally achieved through a sequence of steps called the design process. Based on the work of various researchers (Walker, 2000; Moriyama, J., Satou, M., King, C., 2002). Figure 1 presents is an overview of a Design Process that can be followed in almost any technological problem solving activity. While the process has been divided into a number of discrete steps or phases for purposes of clarity, in reality one tends to "jump" between steps as the ideas take shape and one develops the solution to the chosen problem.

Figure 1: Design Process



Purpose of the Study

The purpose of the research was to investigate the effectiveness of the Technology Fair with hands-on activities in developing undergraduate student's problem solving skills.

More specifically, the purpose of the study was:

a To examine whether the Technology Fair influences undergraduate students' involvement and interests in science and technology b To improve our understanding of the processes used in developing technological problem solving and decision making strategies and how the Technology Fair could contribute in this direction.

Research Design, Methods and Sample

The design of the research was based on the preparation and assessment of a technology fair. Primary school students with the assistance of university primary education students were responsible for identifying a human need, formulating a technological problem collecting information and developing an appropriate solution. Each university student was responsible for collaborating with one primary school student on a single technological project.

In this context, Technology Fair projects provide an opportunity for interaction between undergraduate student teachers and elementary school students so that they can work as a team with shared but different goals: the child aims to solve a problem and present both the problem and the solution during the Technology Fair; the student – teacher aims to use the interaction as a process for helping the child develop problem-solving and decision making skills through a systematic approach.

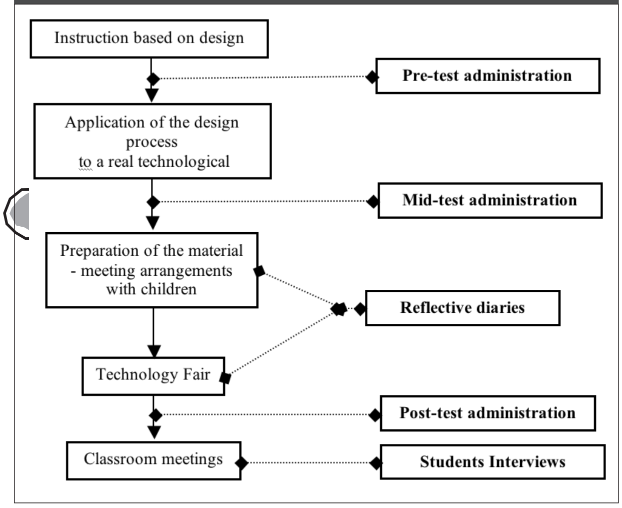
The Technology Fair was held with the cooperation of a local primary school in November 2004. During the fair, each student teacher displayed a poster describing the design process and the artifact they constructed. Additionally, the children engage the public in a specific aspect of their work through a specially design interactive exhibit.

In order to assess their understanding about the design process, a number of tasks were selected and organized into pre-test, mid-test and post-tests. Tests were administered to students before and after the preparation of the technology fair, respectively (25/10/2004, 8/11/2004 and 29/11/2004). All tests included the same tasks. In addition each student teacher was asked to keep a detailed reflective diary after every meeting with the child. These diaries formed an additional source of data. In the diary each student teacher recorded all the information about difficulties they encountered and how they were able to overcome them. Additionally, teaching methods, emotions and ideas were reported after each meeting with the primary school student. Following the completion of the technology fair 12 students were selected and interviewed about their experiences, problems and difficulties faced as well as their interest while working for the fair. Figure 2 shows the design of the research.

Sampling

The participants of the research were 85 undergraduate students studying to become primary school teachers at the Department of Educational Sciences, University of Cyprus, enrolled in a compulsory course on Design and Technology.

Figure 2: The research design



Results

Responses to pre-tests, mid test and post-tests were analysed using the phenomenographic approach developed by Marton (1981).

The test consisted of 8 tasks that required understanding and implementation of the problem solving process in order to solve a new technological problem. The answers for each task in the test were scored from 1 to 10. A synopsis of the results is presented in Table 1. We can see that students responded slightly better in the mid-test as compared to the pre-test ($p<0.01$, $t=-6.623$). The mean difference in the responses to the pre-test and mid-test is statistically significant at the level of $p<0.01$. The correct responses in the post-test was significantly different from both the pre and mid test ($p<0.01$, $t=-65.58$ and $p<0.01$, $t=-61.47$ respectively). The following table indicates the results from the test.

Table 1: Results

Task	Mean Test Scores (out of 100)		
	Pre-Test	Mid-Test	Post-Test
Problem Identification	31	36	76
Design Brief	38	46	79
Specifications	40	41	76
Information search	28	28	71
Alternative Solutions	23	26	69
Choice of preferred Solution	31	33	72
Test – Evaluation	36	37	71
Case study	32	34	68

Indications from students’ Reflective Diaries and interview

Almost every student characterized the opportunity to participate in the Technology Fair as an important experience for their future teaching career. From their reports, it can be seen that students encountered a number of difficulties during the process and invented innovative ways to overcome them.

After the Technology Fair most students expressed the belief that they are confident in teaching the subject of Design and Technology in primary schools. For example, one university student said: "I found the process to be more fun than I thought, and now I am very confident that I can overcome any difficulties I might face in the teaching of the subject".

A significant number of students express their positive dispositions and values gained through the Fair. They expressed the importance of hands on activities, the ability to transfer the knowledge and strategies used through the fair to other technology projects. They also consider themselves to be more effective in identifying technological problems and to overcome possible obstacles that they might encounter in the process of teaching problem solving skills

A large percentage of university students (86%) reported in their reflective diaries that primary school students worked through the design process with enthusiasm and positive attitudes. The whole process and the presentation of their work in the fair seem to enhance primary students' motivation and interest in the areas of technology and science.

Conclusions

The purpose of the study was to examine the influence of the Technology Fair in developing undergraduate students' problem solving skills. The analysis of the results indicates that the Technology Fair has a significant influence on improving students' understanding and application of problem solving and decision making strategies within the area of design and technology.

From the analysis of the reflective diary kept by university students, and their work (before and during the Fair) it can be concluded that the Technology Fair contributes to the development of positive values and attitudes in science and technology education. Furthermore, the Technology Fair fosters cooperation among the University of Cyprus and local schools. Important factors that emerge from previous research on the Science Fair and are confirmed by this study for the Technology Fair are the enthusiasm and the motivation that this kind of education conveys to students (Czerniak & Lumpe, 1996, Duggan & Gott, 1995).

Further research should also include the design of teaching material to support the Technology Fair activities. The way students select their solution to the problem from a number of alternatives, through optimization, should be reconsidered (even though a significant improvement was achieved from pre-test to post-test) and a better design strategy should be considered in order to achieve better results. This pilot study also identified a number of limitations that could be improved in future designs of the Technology Fair.

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SUNSTEP Moving into a New Dimension of Knowledge Through Enjoyment

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Abstract

The South African Education Department presently experiences a phase of major change, which affects all role players. SUNSTEP (Stellenbosch University Schools Technology and Electronics Programme) seeks to assist teachers in blending the Revised National Curriculum Statement (RNCS) with good Technology classroom practice. Until the RNCS was in place, SUNSTEP was an awareness programme, introducing electronics into schools and exposing children to basic electronic ideas. Since the roll out of the RNCS, many teachers struggle to unpack the RNCS policy and come up with good classroom practice. Providing teachers with electronic kits and a worksheet for Technology: Systems and Control, is no longer sufficient, as they do not know how to do the assessment or apply the content and information innovatively. SUNSTEP compiled a learning programme for Grade 7 teachers to demonstrate how they can fully adhere to the curriculum and teach their (12/13 year old) learners about basic electrical circuits, in series and parallel, and to become problem solvers who demonstrate knowledge and understanding of the concepts.

Introduction

South Africa has a critical shortage of young engineers and scientists, especially from the historically disadvantaged communities for whom engineering, and more specifically Electrical/Electronic Engineering, is not often considered a career choice.

In 1996 it became clear that learners and teachers from 99% of South African schools demonstrated a huge knowledge gap in the fields of electricity and electronics and were not even able to design an elementary electronic circuit. In August 1996 SUNSTEP was introduced by Stellenbosch University's (SU) Electronic Engineering Department as an awareness programme. It was a joint venture between the University and the business sector with the purpose of exposing learners to technological concepts. With the financial assistance of industry, pro-active teachers were hand-picked and their schools were the first in which the programme was implemented as a pilot. Creating an awareness and interest in electronics during the following three years was exciting and by all standards, successful. The changes in attitude amongst these teachers and consequently their learners were phenomenal.

Non-Government organisations (NGO's) such as SUNSTEP are emerging as important partners in educational transformation because of the source of creativity and innovation. Education is pivotal to economic prosperity, as it plays a crucial role in enabling South Africans to improve the quality of lives and contribute to a peaceful, productive and democratic nation. The methodology is activity-based and integrates thinking and action within the context of technological problem solving. Education is one of the most important sustainable long-term investments a country can make, especially where many children have fallen behind.

Technology Learning Area

Curriculum 2005

In 2001 Outcomes Based Education (Curriculum 2005) was introduced in the schools by the Department of Education (DoE) and simultaneously Technology was introduced as a new learning area. In the previous four years SUNSTEP has introduced 42 771 learners (ranging from grade 6 to 9) to the basic electronic alarm kit, which is an a-stable multi-vibrator, as well as to 14 other electronic kits.

Suddenly SUNSTEP management was overwhelmed by the enthusiasm with which teachers attended our training workshops. Woodwork, needlework and art teachers were given the task to teach Technology, but without formal training to do so. In the next four years SUNSTEP took up the challenge and trained 2888 teachers and 103,414 learners in seven of the nine South African provinces.

Revised National Curriculum Statement (RNCS)

Curriculum 2005 has been streamlined into the RNCS. The Learning Outcomes have been streamlined to:

- Technological processes and skills
- Technological knowledge and understanding
- Technology, Community and Environment

Specific outcomes with skills, knowledge, values and attitudes have been built in, as well as strengthened into the RNCS.

The DoE roll out training of the RNCS for grade 7 Technology teachers started in January 2005. The curriculum advisors organise the time, venue and teachers whilst SUNSTEP conducts the teacher training workshops.

Problem statement

- There was much resistance against Curriculum 2005 from the majority of teachers as well as lack of understanding, especially in terms of assessment. However, since 2004 the National Education Department presented an orientation course in the National RNCS to teachers where the policy has been unpacked for them. They were then sent back to their schools to do curriculum development. Many teachers, especially those in the previously disadvantaged areas, do not have the time, capacity and resources to do this.
- There have been several Curriculum changes between 2000 and 2006.

- Learners in the formally disadvantaged areas have a tendency not to take Mathematics and Science, due to lack of opportunities in the past that influenced them to see the subjects as intimidating.
- A lack of properly trained teachers.
- The learner/teacher ratio is often an unhealthy 45/1. Experts blame the full classrooms for the problems regarding Maths and Science.
- The overriding challenge faced by most schools (more so by rural and semi-rural schools) is perhaps still the question of acquiring the necessary tools for implementing Technology. This results in many schools not being able to participate in practical activities unless they are assisted by programmes such as SUNSTEP.

Nature of the SUNSTEP Programme – the solution

The main objective of the SUNSTEP programme is to improve the conceptual understanding of Technology with an emphasis on Electricity/Electronics among teachers and their Grade 4 to 9 learners. SUNSTEP strives to assist learners to master Technological knowledge and skills and to apply these skills to a problem in an innovative way.

SUNSTEP interfaces in the school's project activities by offering both teacher and learner a complete and integrated learning experience with a very tangible hands-on component. As from 2005 SUNSTEP does in-service teacher training for the benefit of the learners by training General Education Training Band (GET) teachers in Grades 4 – 9 to apply the RNCS into good classroom practice in the learning area Technology. The SUNSTEP learning material for Systems and Control for instance, takes the teacher through the whole term with all the enabling activities that the learner will need to execute the big project.

SUNSTEP has developed the lesson material for teachers and learners, which address the learning outcomes, assessment standards and enabling activities. We assist teachers and therefore the learners in the necessary resource tasks, guide them in their investigation activities and lead them to do the experiments through which they will see, understand and learn.

Our aim is to equip the schools (identified by Education Authorities) with the basic equipment and support and orientate teachers, which will allow them to participate meaningfully and on an ongoing basis in our programme. Each grade receives teachers' and learners' manuals, consisting of the full learning programme in Technology. The programme has a good working relationship with curriculum advisors in order to remain aligned to educational needs and to organize workshops and discuss development.

Projected outcomes

Teachers receive technical orientation to equip them with the skills and knowledge to teach Technology with confidence to learners from grades 4 – 9. Grade 9 teachers will be able to teach their learners to solder and assemble a cordless microtelephone, with which they can break into FM radio frequency within a radius of 20 metres and speak on the radio. They will understand the function of the components, the circuit diagram, system diagram and learning activities that lead to comprehension.

Learners will understand the interrelationship between technology, society and the environment. He/she will demonstrate knowledge and understanding of how simple electrical/electronic circuits and devices are used to achieve output as a result of input signals. Grade 7 learners will assemble a basic electrical circuit in series and parallel and the concepts will become crystal clear to them. Learners from informal settlements such as Khayelitsha and Guguletu, where electricity is stolen by means of relay actions, will learn about the safety and dangers of electricity. Those still in shacks will be trained as radio amateurs to enable them to communicate with friends, with their own Morse code radio transmitters and receivers which they will assemble themselves. For Technology the learners must make practical projects, applying their new scientific knowledge to practical problem solving. Some learners even sell their new knowledge and become young entrepreneurs.

Sustainable development

The SUNSTEP programme fills a very necessary gap in the education of teachers in Technology. The whole experience of completing a capability task has been greatly praised by curriculum advisors in the Western Cape, Free State and KZN.

> *"The Technology learning area still needs a lot of support and SUNSTEP has an extremely big role to play to address this problem."* (Mr Pierre Boonzaaier – Chief Curriculum Advisor, Westcoast/Winelands EMDC – WCED.)

SUNSTEP achieves its objectives firstly through services rendered to the Education Department, teachers and learners, and secondly through a product (kits), which is distributed as a vehicle to reach the goals. Since Technology has been implemented as a subject in schools, SUNSTEP has become much in demand. Teachers need the extra help, ideas and curriculum based-material supplied by SUNSTEP.

SUNSTEP has been operating for eight years. The programme is an investment in the education of our youth and much time and effort is spent on developing lesson plans for Technology, which includes Processing, Structures, and Systems and Control: Electrical and Mechanical. Once teachers are trained, they are able to continue on their own, as we work towards the progressive development of technological knowledge and skills.

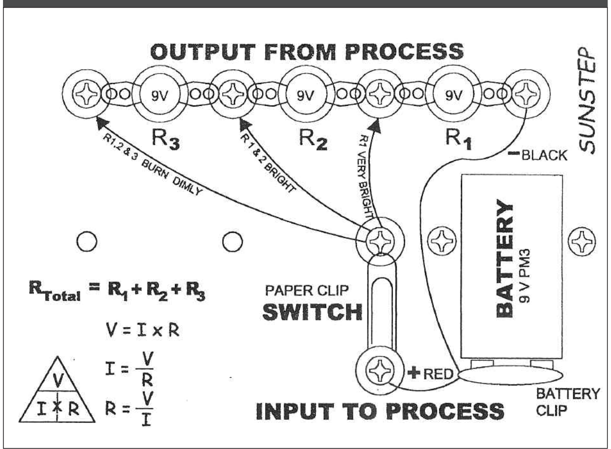
The **learners** develop the ability to use our resources to design solutions to technological problems. The knowledge the learners acquire seeps through to the **community.** Since technological capability to a large extent determines a country's ability to create wealth, the SUNSTEP investment in technological education is an investment in the future prosperity of our country.

Systems and Control

Series circuit

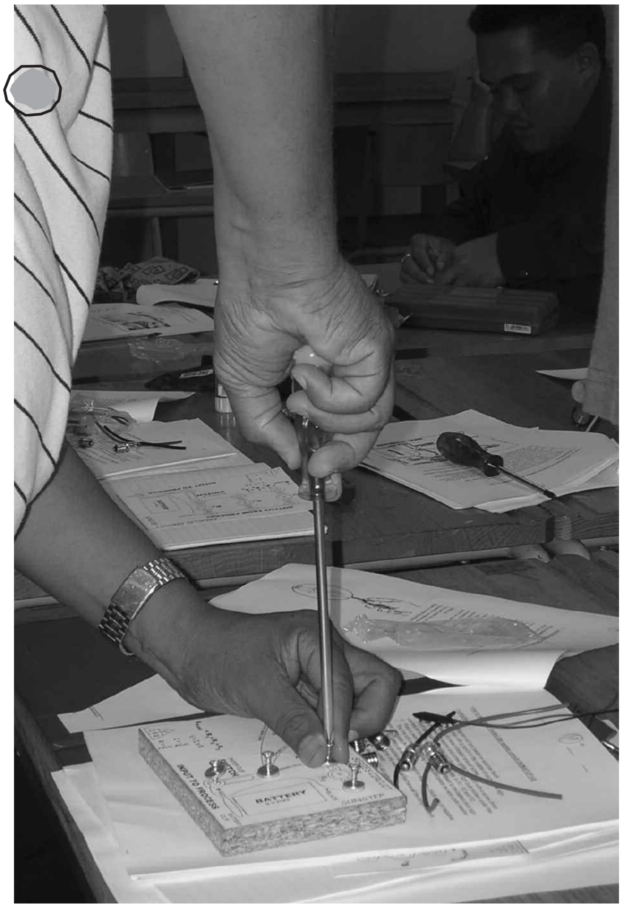
Before starting with current in a circuit, a baseline assessment to establish what the learners already know is done. By looking back and teaching the electric current, using analogies, comparisons and giving reference material, the learners gradually get to the point where one can start with assembling a series and parallel electrical circuit.

Series Circuit



The learners need three electric light bulbs (6.3V 0.3amp), three bulb holders, six screws, six washers, electrical wiring (hook-up), one metal paperclip and a wooden block to use as a base (A5 size). They will also need a battery holder with four 1.5V AA batteries. The tools necessary to complete the task are a screwdriver and punch or nail to make holes in the wood.

One must remember that the majority of the formerly disadvantaged learners and their parents do not have handy-man skills. They also battle to fix things, improve their environment or use technology to make their own surroundings a better place. They have made peace with being poor, do not see themselves getting out of it and do not even dream of tertiary studies. SUNSTEP intends to disturb the status quo and strive to motivate the learners into an attitude change, to make them realise that there is an abundance of other resources and that they too can excel in school. During the training sessions many teachers work very slowly and must be shown something basic such as how to apply the screwdriver correctly, as they did not grow up imitating a role model. See picture below.



The correct way to use a screwdriver

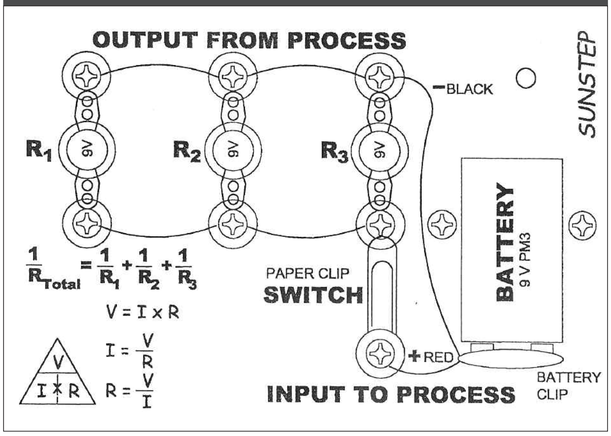
Once the circuit is completed, it is followed by learning activities to test the circuit and investigate the series circuit and conductivity. More enabling activities will keep the learners busy for a term of eight weeks. They must be able to draw block diagrams and understand the systems diagram as seen below.

Systems diagram

Input		**Process**		**Output**
Energy source current eg. battery	→	Circuit closes and current flow	→	Light bilbs glow components/motor

By now the learners know how to cut the circuit diagram out and paste it on the wooden block. It takes them longer to assemble this circuit because there is more wiring, but once they attach the battery pack of four 1.5V AA batteries to the battery clip, their enjoyment and excitement is contagious. Finding out why all three bulbs burn so brightly is fun while five more learning activities follow.

The parallel circuit diagram



Learning while enjoying it

It is amazing to observe how the learners experience satisfaction and enjoyment. Even with a video camera focused on them, they are so absorbed in their work, that they do not pay attention to the distraction. The assembling of the electrical kit encourages constructivist learning. Going hand in hand with this, is collaboration among learners. Some of the learners might have made mistakes, but they assisted each other by comparing their understanding of the instructions.

While developing the learner workbook, we kept in mind that the questions and activities for learners must relate to their experiences. The enabling activities are simple assignments. The use of various learning activities and options stimulates learner participation and interaction and small group discussion.

Assessment

Since Curriculum 2005 started, assessment became a nightmare for teachers from most schools. Paper work doubled and teachers used to tests and examinations were suddenly confused and unsure how to go about it. The RNCS re-addressed assessment and it became more user-friendly. The SUNSTEP document (compiled in conjunction with curriculum advisors) "Analytical Rubric: Summative Assessment: – Project on Electrical Circuits", makes it easy for teachers and not as tedious and time consuming as it was prior to 2004.

The teacher's manual includes assessment instruments numbers one to 13. Indication is given of how the main project, as well as the enabling activities and its outcomes/assessment standards, such as investigate, design, make, evaluate and communicate is to be assessed, and which instrument is to be used. Below is an extract from the assessment document.

Learning Outcome 1: The learner is able to apply technological processes and skills ethically and responsible using appropriate information and communication technologically:

The Assessment number 7.1.5.1 for instance is read: Grade 7, Learning Outcome 1, Assessment standard 5.1

Assessment document – extract

Outcome / Assessment Standard The learner must do the following:	Ass Nr	
Investigates to find out the background context when given a problem	7.1.1.1	Assessment instrument No 13 – Educator
Examines existing products relevant to a problem, situation or need based on key aspects of design	7.1.1.2	Assessment instrument No 13 – Educator
Investigates by performing simple practical tests on parallel and series circuits	7. 1.1.3	Assessment instrument No 13 – Educator
Design Writes or communicates a short clear statement or a design brief for the development of a product	7.1.2.1	Assessment instrument No 13 – Educator
Makes List materials and tools needed for making the product and sequence making steps using simple flow diagrams	7.1.3.1	Assessment instrument No 13 – Educator
Make chooses and uses appropriate tools and materials to make the electrical system with some accuracy	7.1.3.2	Assessment instrument No 1 and 4 – Self
Evaluates the electrical system based on the criteria linked directly to the design brief and some of the specifications and constraints. Suggests improvements or modifications	7.1.4.1	Assessment instrument No 13 – Educator
Communicates Presents ideas (in a project portfolio) using 2-D or 3-D sketches,circuit diagrams or systems diagrams that include notes to communicate designreasoning, dimensions, quantities, enhancements of sketches with colour	7.1.5.1	Assessment instrument: No 2 Self No 3 Self No 5 Self No 9 Self

Conclusion

At the end of 1995 Stellenbosch University's Masters and Doctorate students from the Electrical and Electronic Engineering Department, built the first satellite in Africa. They invited 1500 schools country-wide to participate by designing an electronic experiment to be installed on the satellite. Information would be downloaded every 100 minutes as the satellite orbited above South Africa. Only four schools reacted. In 1996 SUNSTEP was founded in order to make a difference. Many people from other continents view Africa as a dying continent. In spite of efforts to promote investment in Africa through one after the other conference, few attendants leave a cheque behind. Dedicated, committed SUNSTEP members know what a difference technology can make. It is a worthwhile cause, the potential is here – we'll do it. Over a period of eight years more than 146,185 learners have enjoyed learning about electronics the SUNSTEP hands-on way. We will move into this new dimension of knowledge and still keep the learning process one of fun and enjoyment.

Junior Aged Children as Reflective Practitioners

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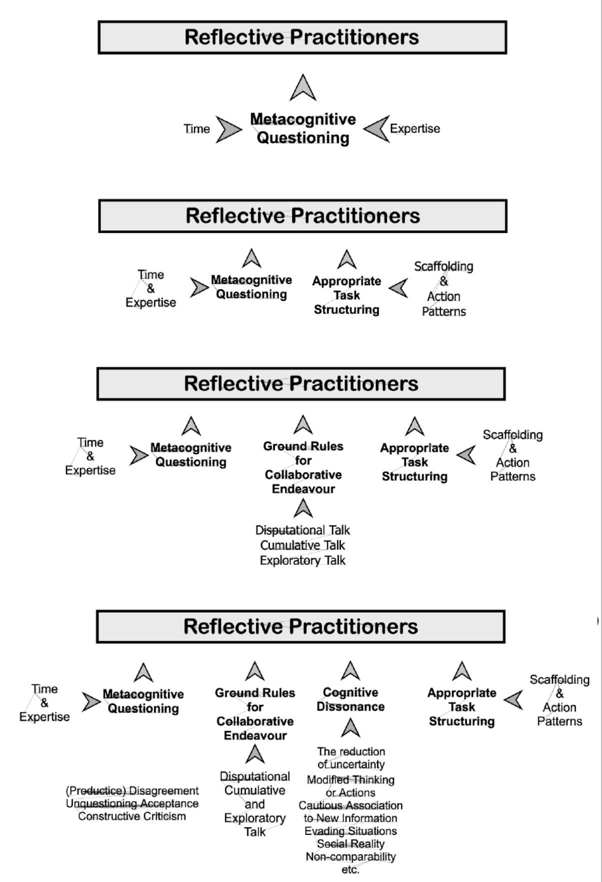
Abstract

This paper focuses on the extent to which children are provided with sufficient opportunities to take responsibility for achieving 'optimised design solutions', through reasoned decision making, when working as a group, and how this position can be supported or hindered by related elements of teachers' classroom practice and or group dynamics.

The discussion is based on my Ed.D work, completed in early 2004, which concluded that the development of young children as reflective practitioners, related to an effective interplay between teachers use of metacognitive questioning, clear task structuring and the management of well organised collaborative endeavour, was generally not well supported in the junior classrooms observed. Moreover, even when these key elements of effective classroom practice were appropriately employed other factors (see Cognitive Dissonance below) impact upon the ability of pupils to reach a shared and suitably justified/agreed understanding of how to make proficient progress, together.

Figure 1: The Development of the Study over Time



Methodology

The approach used was qualitative and interpretive. It was based on evidence drawn from:

- audio and video taped observations of groups of children involved in either the designing and or making phase of a Design and Technology project, including teacher-pupil and pupil-pupil interactions – *I had no direct input on proceedings, acting only as an observer;*
- audio recordings of teacher inputs at the start of a teaching session;
- audio recordings of follow up semi-structured interviews with the groups observed *(usually one week after the observation)*
- audio recordings of follow up semi-structured interviews with the groups class teacher *(usually one week after the observation)*

Dialogue from observed sessions was evaluated as it was transcribed. A colour coding system was adopted to aid the process of identifying particular forms of verbal interaction. *(e.g. red: aspects of metacognitive questioning, blue: reflective practice, green: questions to be raised in post observational interviews).* As such, analysis ongoing *(in-situ),* rather than end on. Initial teacher inputs and post-observational interviews were also transcribed and analysed.

Overview

> *'If you cannot increase reflective power in people, you might as well not teach, because reflection is the only thing in the long run that changes anybody.'* (Howe, A. 1997 p.12)

For me, reflection has to be seen as a key component of design and technology capability, not least because without a willingness on the part of pupils to think in a critically constructive manner, products cannot develop as proficiently as they might. Moreover, such proficiency seems to develop best within classrooms in which children feel confident about taking and making their own independent decisions and secure in their use of effective reasoning skills.

In this context five major issues were considered, as discussed below:

1 Metacognitive Questioning

Dominowski (1998) suggests that the encouragement of individuals to provide reasons for their choices and actions often results in improved task performance. Moreover, he suggests that verbalization is most effective when it is centred on the use of what he called 'metacognitive questioning'. That is, questions that direct problem-solvers to reflect not simply on their intentions but why such intentions form part of the strategies they adopt, as a means of securing a resolution to a particular problem.

In the context of my research, metacognitive questions were seen to be those which prompted pupils to:

- Identify, clarify and justify lines of thought or action, including alternatives – based on reasoned argument that is either self or other-oriented.
- Evaluate in terms of judging one line of thought or action against another, including the monitoring of suggestions or progress involving cross checking, demonstrating aspects of doubt, a willingness to challenge views etc. based on reasoned argument that is either self or other oriented.
- Plan ahead, based on reasoned argument that is either self or other oriented.

They were felt to be significant as part of a repertoire of mechanisms supporting both individual and effective collaborative endeavour, centred on reflective thinking.

It should be noted that, pupils were judged, as a mirror image of metacognitive questioning, to operate as *reflective practitioners* if they could be observed to utilise decisions and actions that stemmed from measured deliberation.

2 Effective Task Setting

I would argue, that children should be encouraged, when working collaboratively, to think about only one, or at least a limited number of key elements as an aid to a collegiate approach to proficient problem resolution. In observed sessions, it was often the case that too much was being asked of young people at any one moment in time. As a result, groups failed to focus on the essential requirements of the task in hand. As such, teachers need to give sufficient attention to the way in which group based, practical problem-solving activities are managed; not least, in terms of breaking 'global problems' down into manageable, bite sized chunks.

As Mercer (1996 p.365) notes:

> *'We needed to look at the ways activities were set up by the teacher, and what the teacher expected the children to achieve from doing the work.'*

In this context Edwards and Mercer (1987 p. 23) citing Bruner, saw 'scaffolding' as a means of aiding a pupil to 'internalise external knowledge and convert it into a tool for conscious control' and it is the scaffolding of the development of pupils' procedural and conditional knowledge that is critical here. That is, the development of children's understanding of when, how and why to do things in a particularly ordered sequence.

For Maybin et al (1992) scaffolding is an aid to reducing the scope for failure. However,:

> *'It is not just any assistance which might help a learner accomplish a task. It is help which will enable learners to accomplish a task which they would not have been quite able to manage on their own, and it is help which is intended to bring learners closer to a state of competence which will enable them eventually to complete such a task on their own.' (p.188)*

Here, help can be seen to relate to both effective task setting and metacognitive questioning, each supporting the notion of reflective practice and optimised solutions, aided by purposeful collaboration during social interaction.

Whilst in many primary classrooms all participants (teachers and pupils) may lack some relevant declarative, procedural and or conditional knowledge and skills, this need not prevent teachers, during verbal interactions, encouraging children to 'reflect', to 'think before doing'. Consequently, it is the process of reasoning, rather than the distinctive content of the discussion per se, that is to be valued if children are to be encouraged to work in a more measured way. It's about teachers and children valuing reasoned decision-making, not least in terms of focusing on relevant aspects of the task in hand.

Meadows (1993), reflecting on the work of Voss, references the importance of an ability to analyse problems into a sequence of appropriate sub-problems and notes the need to teach such problem-solving strategies in contexts where they are useful. In similar vein, Stephenson (1997) suggests that children need a structure for the way they undertake investigative and problem solving activities; whilst Hennessy and McCormick (1994) argue that teachers need to provide opportunities for children to be able to engage with and to value sub-processes in order that they begin to build up their own understanding of how such sub-processes might best be used. Fisher (1990) offers a more direct overview, suggesting that children need clues to help them break problems down into manageable steps. For him, children need to be:

> *'Encouraged to verbalise what they are doing, to exercise their linguistic intelligence in monitoring their actions and explain to themselves (or others) what they are doing. In gaining more control over intellectually challenging tasks a child is learning how to learn.' (p.121)*

Lyle (1996), also saw task setting as a key component of effective collaborative endeavour. Recognising how important it is for teachers to:

> *'Reduce uncertainty for children and ensure that they know what they are doing and why in order to increase the chances of full participation, to enable them to generate ideas and to retain ownership of these ideas.' (p.19).*

I would argue that if children are encouraged to focus on the most relevant aspects of a problem, then this will support their engagement in what Mercer et al (1999) have termed 'exploratory talk' (see below), a critical aspect of 'reflective practice'. It should also reduce the tendency, noted during fieldwork, for groups to fragment, with individuals or pairs essentially operating independently of each other.

As Wood (1991 p.106) notes:

> *'Without help in organizing their attention and activity, children may be overwhelmed by uncertainty.'*

Indeed, if teachers' initial inputs were more securely framed, then I would contend that groups would be able to reach, 'intersubjectivity' – based on the willingness of individuals to give up a currently held position *(situation definition)* in favour of another *(situation redefinition),* as they realign themselves towards an agreed 'action pattern' – a logically structured approach to problems in hand.

Teachers, therefore, need to provide guidance, at the beginning of a task, which promotes a clear understanding of the need for individuals working as a group to reach reasoned joint agreement on how best to sequence their approach to goal-directed activities. This can be linked to three theoretical constructs, identified by Wertsch (1984), in his attempt to clarify the notion of the Zone of Proximal development. These are:

- 'situation definition'
- 'action patterns' and
- 'intersubjectivity'.

With regard to the former, Wertsch argued that within the ZPD adults and children, in the context of collaborative endeavour, might tend to represent objects and events in different ways. In the context of this study 'objects' were viewed as the: products of reasoned-thinking leading to efficient action. As noted above, there is a need for teachers to encourage pupils, working collaboratively, to try to reach a joint understanding of how best to move forward. An understanding, that is, of the strategic steps required to support proficient problem resolution. A demonstration of their ability to effectively apply what they currently know and can do, together. Evidence from the study indicated some recognition, by pupils, of the benefits that might accrue from agreeing appropriate group-based action patterns. However, such evidence was limited, perhaps as a result of the reduced opportunities for creative activities, currently afforded within the primary curriculum, undermining the development of 'shared agreement', thereby leading to 'action' rather than 'reflection' being valued more/prioritised by most pupils.

Additionally, Wertsch (1984) contends that when, at the outset of problem solving tasks, children come to define the purpose of a task differently from a supportive adult, the consequence will be a variation in perceived 'action patterns': logically and efficiently structured problem resolution. Such variations may also differ at a personal level whereby individual pupils within a group fail to share an aligned perspective on a best way forward. To avoid the likely consequence of an impasse, scenarios where pupils drift into standoff positions that undermine progress, one or more of the participants will have to give up their current situation definition (perspective on expected outcomes), and its associated action pattern (preferred sequence of events, including strategy choices) in favour of a revised and agreed position, hopefully based upon a critically constructive dialogue. For Wertsch, it is this relinquishing of an existing situation definition, and its associated action pattern, in favour of a new one (situation redefinition) that is a fundamental quality of movement within the zone of proximal development; a 'qualitative transformation' (p.11) that, as I understand it, augments pupil's cognitive development. Participants (teacher and pupils) in such interaction may begin at different or comparatively similar starting points, but what is important to the development of an optimal solution is that, where necessary, modifications to currently held positions, on the basis of reasoned judgement, secure intersubjectivity.

3 Ground Rules for Collaborative Endeavour

Lovelock and Dawes (2001) indicated that many children can find group based activities a difficult experience with few of them able to effectively pool their mental resources, combine ideas, negotiate compromises or ask for/provide justifications for suggestions made. Furthermore, a number of authors (Hardman and Beverton, 1998 Lyle, 1996 and Gokhale 2002) recognise that effective interaction in group settings has to be supported by teachers making the purpose and desired outcomes of a task, and the roles that children are to undertake, clear. Indeed, for Lyle, the roles include those of leadership, negotiation and support of others. Moreover, she suggest that:

> *'Successful educational activity through group work depends on learners (a) sharing the same ideas about what is relevant to the discussion, and (b) having a joint conception of what they are trying to achieve by it.' (p.362)*

In this context Mercer (2000) has suggested a need for teachers to encourage children to engage in 'exploratory talk', whereby pupils connect critically but constructively with each other's ideas. That is, where information is offered for joint consideration, where proposals may be challenged, where alternatives are articulated and justified and concurrence is sought as the basis for jointly agreed progress. In all of this, knowledge is made publicly accountable and reasoning is visible in the talk. In this respect Mercer et al (1999) suggested that as a basis for effective collaborative endeavour, and for me the reflective practice than can stem from such approaches, teachers need to establish firm ground rules based upon pupils:

- Sharing all relevant information;
- Seeking to reach agreement about what line(s) of thought to follow/action(s) to take;
- Accepting that the group (rather than individual members) takes responsibility for decisions and actions and for any success and failures that ensue;
- Recognising the need to provide reasons to back up assertions, opinions and suggestions;
- Recognising that challenges are acceptable;
- Recognising that alternatives should be discussed before a decision is taken;
- Understanding that all in the group should be encouraged to speak by the other group members.

4 Cognitive Dissonance

However, pupils' readiness to engage in this type of interactive exchange may well be adversely affected by factors that reduce their willingness to reach a shared understanding. This is in keeping with Lyle's (1997), suggestion that among other things, pupils expectations, status, prior achievement and communication skills will differ and impact upon the notion of 'meaning making'. Such factors, in the context of my study, were related to the concept of 'cognitive dissonance' (see Festinger,1957); and though this paper does not permit a full coverage of the term, evidence from observations and interviews suggested, for example, that:

- a pupil's failure to engage critically with their own or others' intentions may stem from perceptions of the relative levels of personal expertise (status) within a group and an unwillingness to expose associated personal limitations. A useful example is provided below:
- a reluctance on the part of a pupil to give up a current line of thought or action may often have been a function of their wish to minimise the level of personal uncertainty, leading, in many cases to the entrenchment of existing positions;
- friendships often led to a collective view, held by weight of numbers within the group, even though the supported line of thought or action was not, in reality, secure;
- simple agreement was often reached to obtain the reward of moving quickly from reflection to action, from thinking to doing.

Summary

First, and most positively, where children were seen to supported, at least to some extent, as reflective practitioners, then problem resolution was based, in part, on reasoned decision making: strategies developed on a clearer, co-constructed understanding of how best to move forward. However, evidence suggested that such favourable situations are not a key feature of collaborative group work during practical problem solving activities and in the majority of cases interaction (teacher – pupil(s), pupil – pupil) did not afford associated benefits. Rather, observed classroom interaction often indicated a lack of engagement by pupils with one another's ideas. In Mercer's (1996) terms, interaction exhibited limited evidence of 'exploratory talk'.

It was also noted that children often operated in a more reasoned manner during teacher-pupil interaction than when engaged with their peers. This may well stem from some of the intuitive beliefs that individuals held about the own level of expertise/personal status etc. within the group.

Finally, 'time' limitations and individual teacher's perception of their subject based expertise (design and technology) also seem to impact on the extent to which children are supported as reflective practitioners.

The following key findings and associated recommendations were thus identified:

- The role of the teacher is both central to the aim of promoting young children as reflective practitioners and complex;
- The encouragement of young children as reflective practitioners is related to an effective interplay between metacognitive questioning, clear task structuring and well organised collaborative endeavour based on sound ground rules;
- However, even when these key elements of effective classroom practice are appropriately employed to support children when working as a team, other factors seem to impact upon their ability to reach a shared and suitably justified/agreed understanding of how to make proficient progress. In short, to 'reason together'. These factors, which tend to undermine a group's ability to work towards optimised solutions to the problem(s) they are faced with, have been linked to the notion of 'cognitive dissonance'. This includes, for example, children's concerns about their personal levels of uncertainty, their perception of their place within the group: not least how they view their own and others designing and manufacturing skills, combined and overriding positions based on friendship rather than reasoned argument, in the most critically constructive sense, the need for reward or a simple desire to be getting on with the 'doing' rather than engaging in further 'thinking' Whatever the cause, the outcome can be seen to be part of the complex make up of children asked to interact in group settings.

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Creative Problem Solving in Technology Education a Juggling Act

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Abstract

From 2003 a set of technology education exemplars and a matrix were made available to New Zealand schools. These exemplars are part of an assessment strategy announced by the Minister of Education in August 2000. One component of the matrix describes a characteristic of technological literacy as 'Being Innovative, Creative, and a Risk Taker.'

This paper will highlight the results of a pilot study looking at a framework which was design to support creative problem solving in primary classrooms. A year two class are introduced to the framework using the Krusty the clown character from the popular culture programme – The Simpsons. This framework called JUGGLE was designed to develop the characteristic highlighted above.

The paper highlights these key factors;
- ***Using popular culture to engage children in technology education.***
- ***Teaching children to problem solve creatively.***
- ***Developing frameworks to support creativity in technology education.***

Introduction

Since 2003 a set of technology education exemplars and a matrix have been available for use in New Zealand schools. These exemplars are part of an assessment strategy announced by the Minister of Education in August 2000 (O'Sullivan 2003).

A number of key characteristics were identified one of which was 'Being innovative, creative and a risk taker. Technology education is becoming synonymous with developing creativity in children. However, there are few examples of strategies for promoting this key characteristic.

> *The characteristic "being innovative, creative, and a risk taker" is shown in the way students make unexpected connections, combine elements in new ways, and dare to advance their ideas (individually or collaboratively). They persevere in pursuit of achievable solutions and successful exploitation of their ideas. Deepening and widening knowledge is likely to enhance creative, innovative thinking throughout students' technological practice.*

http://www.tki.org.nz/r/assessment/exemplars/tech/matrices/pdfs/matrices_tech.pdf 22/03/05

This paper will highlight a pilot study looking at a framework which was designed to encourage creative problem solving in primary classrooms. A year two class were introduced to the framework using a character from popular culture Krusty the clown from the Simpsons. This framework called JUGGLE was designed to support the characteristic from the matrix discussed above.

According to Benenson (2001) research in technology education must involve both classroom teachers and university faculty to alleviate that "in the dark feeling" some teachers express about research.

> Teacher: *"I actually found it was really neat because you gave me a framework, and I just interpreted that to the level of the kids. It was a nice way to work with somebody from the academic arena….right the way through to actually making it work out in the classroom".*

This paper will highlight a joint attempt by a university lecturer and classroom teacher to utilize a framework which could be used with younger children to support this key creativity characteristic. When the exemplars and the associated matrix were released to New Zealand schools it was recognised that trying to level innovation and creativity was futile. What was published was a list of descriptors which highlighted possible attributes which teachers should try and promote. No guidance was given to how this might be achieved or assessed. As Kimbell (2002) identifies *"we measure what is measurable and that typically leaves innovation and creativity out in the cold."*

> Teacher: *" …having the framework set out like this helped me to give a lot more formative assessment …it was just so easy, it was a natural thing to be able to assess the children, give them lots of feedback because it was all in the framework."*

Lakoff and Johnson (1980) describe concepts we live by as having a controlling function far beyond that of just language and intellect. These concepts they argue are metaphorical in nature and influence how we think and act. Whilst developing this framework the authors acknowledged the work of Lakoff and Johnson (1980) and the work of Ryhammar and Brolin (1999). The metaphor of technological problem solving being a juggling act was seen as a good starting point. Obviously relating metaphors to younger children can be a difficult exercise. To promote interest the developers thought of using a well known children's character Krusty the clown from the Simpsons. Clowns juggle, so children know this therefore connection made!

Literature review

While the concept of "creativity" has been widely researched for many years, disagreement remains among researchers as to what creativity is and how it develops (Lynch & Harris, 2001).

The matrix provides a list of descriptors for the ways pupils may show their creativity:

- Seeing possibilities no-one else does;
- Recognising and accepting the challenge;
- Being brave;
- Exploring different tangents or options;
- Valuing ideas;
- Being willing to explore;
- Considering taking risks;
- Persevering and focusing on engagement;
- Thinking laterally and flexibility;
- Showing excitement about creativity;
- Synthesising;
- Making unusual or different connections;
- Showing strong self motivation;
- Showing originality;
- Looking forward and back.

According to Buchanan (2001) the cognitive processes which generate creative outcomes do not differ from everyday thinking. Moreover, it is the context which is different. Craft (2000) notes that technology education has at its core the need for children to think and act creatively. Craft also highlights that children need to understand the physical properties of materials and how they can be manipulated in order to realise their ideas. This became particularly important as the researchers decided to introduce a new material to the children because of its properties. Howard-Jones (2002) identified that creative problem solving is essential to technology education-also that it can be observed. The researchers in this case believed that by developing a simple framework they could support and observe in practice children's creative problem solving.

Methodology

The research was carried out as a single site case study focussing on a framework that was developed to try and support younger children with technological problem solving and creativity. The site chosen school X is a decile 1 medium sized costal primary school in New Zealand. (Decile 1 schools draw their students from areas of greatest socio-economic disadvantage). The school caters for 5-11 year old pupils; the location is in a semi industrial part of the town. The school has two partial Maori immersion classes. Students benefit from the extensive playgrounds and considerable extra classroom space available to support learning programmes. A large, newly remodelled library and modern computer suite provide students with high quality information and communication technology learning experiences.

The study group was a year 2 class with 16 mostly six year old children. An activity was planned by both the class teacher and the researcher to compliment an existing unit of work. Many schools begin there new year with "getting to know you" sessions where the children can discuss their uniqueness and identify things that are of interest to them. It is used as a self esteem exercise part of the social studies curriculum in New Zealand.

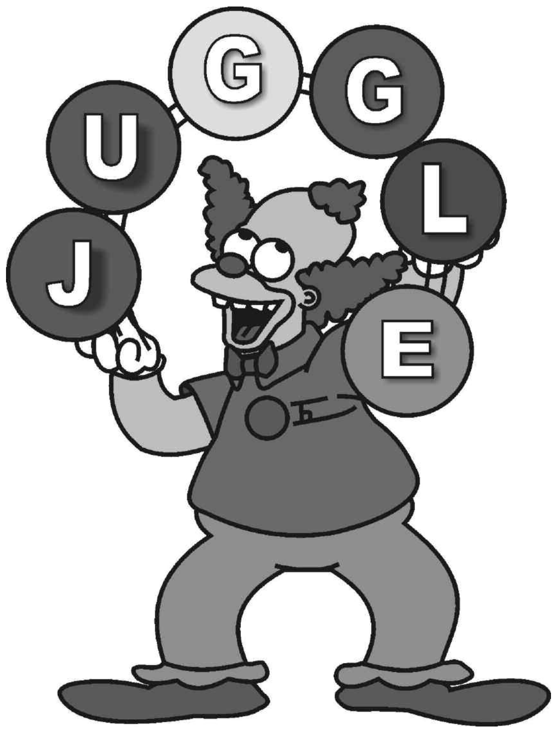
This class had been buddied with a new entrants class and were planning reading time where they would read with the new entrants. To enhance this reading exercise the research partnership decided to develop an engaging reading mask which would reflect the pupils themselves and the things they were interested in.

The researcher developed a framework to help them with developing their mask:

J Children Justify the problem i.e. identify if it is worth doing.
U Children Unravel the issues surrounding the problem.
G Children Gather information and resources required to solve the problem.
G Children Generate ideas and create possible solutions.
L Children Look for opportunities to be original.
E Children Explore and evaluate their work.

The teacher unpacked this to create a child's speak version.

J Just what is we are doing and why?
U Usually good masks would have….
G Get more information.
G Get some ideas in my head.
L Lets see if I can make mine different.
E Evaluation



The teacher's version reflected language used in other areas of the curriculum in this school and therefore language the children were used to. This was a good example of meeting Benenson's suggested joint action research.

The project lasted for five weeks with blocks of time ranging from an hour a day through to whole mornings or afternoons. The teacher developed a flip chart which had Krusty the clown juggling six balls each with a letter from the JUGGLE framework.

The teacher developed an eleven page workbook which the children used to record the process they went through. Some of the pages were headed with the JUGGLE framework. Resources about masks etc. were located and placed in a resource corner. Pictures of masks were placed on a display board. The children had show and tell sessions with existing masks.

The research followed an idiographic qualitative approach i.e. simply observing what happened to a group of students in a particular technology class. The research question was to see if a simple framework might support novice problem solvers develop a creative response to an opportunity. Qualitative data was collected through video recorded observations of class activity which were supported by field notes. Interviews were held with individual participants both pupils and teacher. These interviews were recorded and transcribed. Evidence from pupil workbooks was reviewed by both the teacher and the researcher and interpretations were discussed. Outcomes were photographed and analysed against other collected evidence.

Findings and discussion

The children responded immediately to the chart containing Krusty. Most knew he was a character from the Simpsons and everyone recognised him as a clown. Although the researchers were a little concerned about the character's antics on the programme, nobody mentioned any negatives associated with the character.

> Interviewer: *'tell me about Krusty first?'*
>
> Teacher: *'Yeah I thought it was good motivation; it was a familiar character to them which helped.'*
>
> Interviewer: *'Did any of the negative connotations of Krusty come through?'*
>
> Teacher: *'No.'*

Amabile (1994) talks about an *intrinsic motivation principle of creativity:* This is where people are most creative when they feel motivated primarily by the interest, enjoyment, satisfaction, and personal challenge of the work itself-not by external pressures. The researchers were interested in using juggling as a metaphor for problem solving. The children were more interested in Krusty the clown as a motivator.

> Interviewer: *'Who's that? (Child shown flip chart of Krusty juggling)'*
>
> Child: *'Krusty the clown.'*
>
> Interviewer: *'Krusty the clown, have you seen him before?'*
>
> Child: *'Yes.'*
>
> Interviewer: *'Where?'*
>
> Child: *'On the Simpsons.'*
>
> Interviewer: *'What is he doing?'*
>
> Child: *'Juggling.'*
>
> Interviewer: *'How many balls is he juggling?'*
>
> Child: *'1, 2, 3, 4, 6.'*
>
> Interviewer: *'Six ,and what is on the balls?'*
>
> Child: *'Letters.'*
>
> Interviewer: *'Did your teacher tell you what they were for?'*
>
> Child: *'Yeah'*
>
> Interviewer: *'And what were they for?'*
>
> Child: *'For helping you.'*
>
> Interviewer: *'Helping you to do what?'*
>
> Child: *'Do your work.'*
>
> Interviewer: *'How did it help you?'*
>
> Child: *'It helped us to get ideas in our head.'*

The researcher decided to introduce a 'new' material and process to the children to encourage a more personal response and to overcome some of the manipulation problems younger children have when shaping materials. The material Plastazote is a high quality, lightweight, closed cell polyethylene foam that is nonallergenic. It may be used in direct contact with the skin. It is heat mouldable, easily worked and washable. The children under close supervision were allowed to heat an A4 coloured sheet of plastazote in an oven then with the help of a teacher aide this was placed on their face and press moulded into a truly personal mask foundational shape. Mumford et al (1997) noted that having appropriate resources influences those trying to be creative and indicates that their endeavours are worthwhile. This was confirmed by our research.

The research also confirmed the importance of background knowledge to creativity 95% of children during the interviews identified plastazote as a plastic that it came from oil and had plastic memory. This information was discussed with the children during the project and they saw plastic memory in action when they were able to put their masks back in the oven for the plastazote to return to its original shape. This 'newly acquired' knowledge seemed to validate the learning experience for the children.

Interviewer: *'what is this material called?'*

Child: *'Plasterzote.'*

Interviewer: *'What is Plasterzote made of?'*

Child: *'Plastic.'*

Interviewer: *'where do we get plastic from?'*

Child: *'From oil.'*

Interviewer: *'How did you make it like that?'*

Child: *'Put it in the oven and put it on the face.'*

Interviewer: *'So if we put it back in the oven, what would happen to it?'*

Child: *'It would go back down.'*

Interviewer: *'So what is that called?'*

Child: *'Plastic memory.'*

The research partnership had developed the framework to help the children and teacher with the process. To offer some support because juggling all the different demands of problem solving for young children or novice problem solvers can be a particular issue. An issue which can impact on their ability to be creative. Observations and interviews with both the children and the teacher confirmed it was successful in that regard.

Interviewer: *'Do you think the juggle framework helped you?'*

Child: *'Uh huh.'*

Interviewer: *'How did it help you?'*

Child: *'It helped me like, when you are doing J it helps when you put it up there that you know what is that you are doing and put a U usually good masks have and G get and we learn about plastazote.'*

Interviewer: *'Next time you do a project where you have to sort things out; do you think you should use the Juggle framework again?'*

Child: *'Yes.'*

Interviewer: *'Yes you should. Why is that?'*

Child: *'So you know that you know what you are doing.'*

The children and classroom teacher discussed the framework on many occasions noting where they were and where they needed to get to. Also the teacher was observed during conference sessions with individuals where the framework supported questioning which validated the children's work. This perception that the framework had helped them with their problem solving and developing a creative response was confirmed by the classroom teacher.

Interviewer: *'So do you think the Juggle Framework helped them?'*

Teacher: '*Definitely because I mean, that was so obvious, the kids that missed out on a part of the framework through absence their end product was a lot weaker.'*

Interviewer: *'Were there anyways in which the framework helped you as the classroom teacher?'*

Teacher: *But it was definitely good from my perspective to have it to scaffold to have it what they were doing and also having the framework set out like this helped me to give a lot more formative assessment as that on going stuff as well. It was just so easy, it was a natural thing to be able to assess the children, give them lots of feedback because it was all there.'*

Interviewer: *'Do you think that the framework helped with children's creativity?'*

Teacher: '*Yes I do.'*

Interviewer: *'In what way?'*

> Teacher: '*For them it was good they could get everything down and have it to refer back to and so that they were freer to be creative they weren't trying to hold on to so many bits and chunks of information that often stifles their creativity. It was all there to refer to so they didn't have to have that in their heads the whole time. They could just concentrate on one part of it at a time which meant they could be more creative.*'

When you think that they come up with the designs before they knew about materials a lot of them were already pretty sold on their design. It is pretty amazing that they were that creative that they were able to think outside the square and think of a curly shape without knowing about pipe cleaners.

During the interviews children were asked about the specific letters, most could not remember straight off what the letters stood for. However, they were happy to use examples from their log books to express how the framework had helped them. They did recognise one letter particularly G (get ideas in my head) this was because they had previously had a writing exercise using that phrase. The children had show and tell sessions with existing masks and these were evaluated against the U (usually good masks would have) component of the framework. They also developed specific criteria and a simple specification from that letter.

> Interviewer: '*Any specific examples of where people respond to one of the letters and do something?*'
>
> Teacher: '*…some of them did really good designs from their own personal information and what they were into and what they liked. Then there was lets see if we can make mine different, when they got to that some of the other ones who had copied thought oh gosh, they suddenly realised that theirs didn't really reflect them personally so they had to go right back to review their whole process using the framework.*'

Obviously this is a small specific pilot case study therefore transferability of these findings cannot be guaranteed. However, all the children interviewed were asked if the framework helped them and if they would like to use it the next time they were problem solving. They all responded positively. The teacher is already planning to incorporate the framework into their next problem solving exercise.

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The Laptop Advantage: Trialling the use of Laptops in Primary Technology Teacher Education

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Abstract

In Semester 2 (August – November), 2004, a class of 50 primary teacher trainees who were studying their compulsory technology education unit, were selected to be part of a laptop trial project. The students were presented with a laptop computer for them to use throughout the semester, and data was collected at different times in a variety of ways to enable judgements to be made about the efficacy of their use. The primary research question was: How has the use of a laptop computer enhanced learning? Qualitative and quantitative data were collected through the following means:

- ***Skills Audit: a pre and post test skills audit was conducted with the laptop (research) group and with the control group (other students doing the same unit without laptops).***
- ***Grades: research and control groups final grades and assignment grades were compared.***
- ***E-portfolio: all students develop an electronic portfolio as part of their unit requirements, in which they were encouraged to reflect about their computer use.***
- ***Discussion Board: the unit was supported by an on-line discussion board.***
- ***Survey instrument: all students completed a research survey instrument.***

This presentation will discuss the findings from this project.

Introduction

Universities continue to scramble to provide adequate computer technology support to their on and off campus learning networks of students and staff. Significant investment in back room infrastructure is a given – help desk support, high capacity servers, ease of connectivity together with effective firewalls against abuse, and significant lecturer professional development. The interface structure varies from dispersed desktop computers, to megalabs with 24/7 access, to wireless laptops, and more commonly a combination of these approaches in any one institution. This paper focuses on a trial of students using laptop computers in a wireless environment in one class at Edith Cowan University.

The class was a group of 50 primary pre-service teachers who were studying their compulsory technology education unit, Technology and Enterprise Education, in the third year of their four year Bachelor of Education degree. There were a total of 270 students in the unit who were divided into groups of 40-50, and it was one of these groups who were presented with laptop computers for their use throughout the 12 week semester. The building in which classes were held, comprising workshops and labs, was equipped with a wireless network.

A survey of the literature indicates that laptop computers are introduced for a range of reasons, including:

- Megalabs cannot keep pace with student demand (Deden, 1998),
- Help ensure student IT skill development
- Enhancing learning opportunities (Mackinnon, 2001)
  - Improve services to all students (Cartwright, 1997),
  - To achieve the goal of ubiquitous computing (Weisner, 1998),
- To achieve digital unity (eliminate the digital divide) (Finn and Inman, 2004),
- To ensure institutional competitiveness (Brown, 2003),
- Make computer technology convenient for students ((Finn and Inman, 2004).

In a literature review conducted by Roschelle, et al (2004), 26 studies were identified that reported a range of benefits of classroom networks. The benefits included greater student engagement, increased understanding of complex subject matter, increased interest and enjoyment, heightened discussion and interactivity and increased teacher insight into student difficulties.

As a result of an analysis of policy documents promoting computer integration, Mathiason (2004) synthesized three categories of expectations from the integration of computers into education:

- Use in teaching – more effective teaching,
- As a facilitator of learning – support individual learning processes, and
- Concrete qualifications – general IT skills will facilitate the communication of subject content.

The rationale for this project was various. The institutional rationale was suggested as "The ECU Advantage Project offers a unique opportunity to create exciting learning and teaching experiences supported by new technologies and based on educationally sound design principles." There were a range of outcomes expected from the project that included the following;

- Supporting the use of notebook and wireless connectivity to assist students to achieve successful learning outcomes in an exciting and stimulating fashion,
- Developing students' confidence, knowledge and skills in the selection and application of technology appropriate to their field of scholarship,
- Achieving an institutional advantage over competitors by adding value to the teaching and learning experience,
- Expanding students' use of online resources and information at ECU (ie learning management systems, library etc),
- Enhancing flexible delivery options for staff and students,
- Making better and more efficient use of space,
- Developing new teaching and learning models utilising mobile computing technology, and

- Integrating technology in the university experience for academic staff by providing educational design opportunities, infrastructure and support.

The lecturers agreed to be involved in this project because the Head of the School of Education was looking for a volunteer. The benefits of having laptops for the pre-service teachers, in a unit of work that incorporates a high level of interaction with technology seemed an appropriate use of such a unique resource. The lecturers in the Technology and Enterprise unit needed support to further develop the unit to effectively integrate a range of rich tasks and so provide a seamless interface between the workshop and computer laboratory components of the work. The extra support from design personnel and freeing of time commitments from teaching loads that came with the laptop project was also an attractive proposition. Like many new initiatives created in the workplace it 'seemed a good idea at the time'.

Technology and Enterprise Education

The compulsory unit the students study is called Technology and Enterprise Education which provides an introduction to the Technology and Enterprise Learning Area. It s aim is to develop students' confidence and competence in the use of a range of resources to solve problems and resolve issues in an enterprising manner. The philosophical basis and values of the learning area are explored through rich tasks.

Students meet for three hours each week in groups of 40-50 and move between a workshop and computer lab, depending on the activity in which they are engaged. Two lecturers teach concurrently, one in the workshop and one in the computer lab.

The assessment tasks for the semester include two assignments and an exam. The first assignment is a research paper about the provision of a museum learning experience that complements a program of work created to support children's learning in a primary setting. The program engages the children in solving a rich task scenario based on a childhood theme such as creating a simple toy. The students also incorporate the Multiple Intelligences theory into their planning. The second assignment is an electronic portfolio which represents the students learning journey throughout the semester. It includes evidence of a range of IT skills, documentation of the design processes followed in the workshop tasks and reflections on progress and achievement.

Software and Hardware

Each student was provided with an IBM Power User Laptop R50-1829-EMO, with firewire card and CD burner. Software was installed on the laptops according to the needs of the unit and included Microsoft Office Suite, 3D Home Architect, Robolab, Kidspiration, Inspiration, KidPix, Smartboard, Windows Media Player 9 and Windows Movie Maker 2.

Conceptual framework and methodology

The research rationale was to embed the collection of the data for the research in the normal class activity in order to avoid possible 'research effects' from skewing the results, although the research group did already feel 'special' as a result of the allocation of laptops to just the one group. For this reason the conceptual framework for the research was related to the underpinning philosophy of the unit. This philosophy could be termed critical constructivism – meaningful, creative, challenging, inquiry based and involving the active applications of educational technology, called a 'technorealism' approach by Walker and White (2001). This approach is particularly appropriate for technology education at ECU where the elements of critical constructivism are quite naturally embedded in classroom approaches: an active approach to learning, the development of a critical approach to technologies, and a designerly approach to processes.

Aligned with this approach, the conceptual framework for the research is an applied system framework (Mathiason, 2004), derived to encompass the concepts of information and communication technologies (the instrument and the communication media), teaching (communication that intends to induce change) and learning (the deconstruction, construction and reconstruction of communication). The effectiveness of the system which is represented by these three elements then becomes the broad focus of the research.

A range of qualitative and quantitative data was collected in order to attempt to analyse the effectiveness of the project. This research report will focus on the data collected from the student reflective journals and their website discussions. This is partly in response to Selwyn's contention (1997) that researchers in IT were only analysing part of the picture by focussing on quantitative research, and that they avoid qualitative and ethnographic methods and the huge advantages they offer. The attempt therefore in this analysis is to develop explanations through an analysis of patterns and themes and to suggest plausible connections (Neuman, 1989) within the conceptual system.

Findings

The student's reflective discussions in their efolio journals and their chats on the bulletin board were relatively unstructured and therefore wide ranging. Relevant discussions were extracted from their source and then analysed for common issues, patterns and themes.

Initial Feelings

The majority of students were nervous and worried about the responsibility of being allocated a laptop. Their concern related to both the practical aspects of caring for the hardware, and also the expectations they felt would be upon them in achieving the course outcomes at a high level. The few who were initially excited by the project were soon joined by the others who quickly overcame their concerns.

> *'I felt overwhelmed by the responsibility to begin with, but this feeling was soon overcome by that of convenience (TC).'*

Convenience

The computers quickly became part of their lifestyle for many students, rather than just a tool to use in completing assignments. The convenience of working on projects at any time and place was a significant advantage to the many students who were juggling family, work and study commitments. The fact that they could also play music and send emails represented a significant enhancement for some.

> *'I have finished up assignments while sitting in my [broken down] car waiting for the RAC, and have searched the internet for resources with the wireless connection whilst relaxing on the lawn in the sunshine at uni (EL).'*

Convenience had another dimension for some students whose working styles were complemented by the use of laptops. For example the student who develops design ideas on bits and pieces of paper, now puts those ideas where they belong as they arise.

> *'Now I just pull out the laptop and put my idea straight into my assignment or whatever I'm working on at the time (EL).'*

The students completed a practicum requirement during the course of the semester in which they had the laptops, and many reflected that this was an opportunity to experiment with tools and activities to which they have not had access in the past. They used it as a tool to promote integration of technology across the curriculum in an authentic manner.

The computers were equipped with a range of software that was to be used in the technology unit. This was a source of initial trepidation for the students, but a very positive outcome by the end of the semester.

> *'I can't believe I know how to use so many software programs (DV)'*

The majority of students felt that their computer skills had developed more than if they did not have a laptop, and more than they expected. This feeling was confirmed by an ICT skills pre and post test that was administered at the beginning and end of the semester, in which the laptop group increased their skill level to a greater degree than other students.

Negatives

There were some negative aspects to being involved in this project for some students, which mainly related to the hardware and software rather than learning and study. The absence of a floppy disc drive was inconvenient for some students, as the digital cameras that were available for loan stored images on a floppy disc. A couple of students thought the computers ran too slow, particularly with all the virus and spyware detection software. One student concluded:

> *'If its green, its biology; if it stinks its chemistry; if it has numbers its math; if it doesn't work its technology (ME).'*

Learning

Not a lot of undirected student comment about the use of laptop computers was related to learning, but as one of the areas of study during the semester related to learning styles and multiple intelligences, some students picked up on this theme.

The majority of students who commented identified themselves as preferring to learn by doing, and having a computer at hand all the time enabled them to use the technology to accomplish many tasks with which they would otherwise be less engaged. It also represented a significant time saving device, with less time being taken to access information and includes a wider range of resources in their tasks.

They also readily saw the application to their teaching and the students in their classes, who could also benefit from a diversity of learning activities because of the diversity of learning styles.

> *'With this [laptop] I will be using my learning style of doing rather than reading or writing and feel that a lot of children in the classroom also have this learning style and will benefit from my new knowledge of these products (SH).'*

Conclusion

The response by the students involved in this project was overwhelmingly positive. For at least a quarter of the students involved, computers were not previously a tool they utilised to any great extent in their work. The students were appreciative of the access to programs at times other than tutorial sessions as this complemented their busy schedules of work, study and parenting. Over 90% of students felt that the laptop enabled them to learn more effective as they became better organized. The students also acknowledged that this led them to become more independent in their learning because of the stimulation and excitement of using the laptop. It was gratifying to have acknowledgement from the group that the use of laptops within this unit provided them with a range of life learning skills for teaching in the future.

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EdaDe – Education Through Design – Theory Closer to Practice

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Abstract

This paper presents the first EdaDe workshop experienced in Florianopolis City (Brazil), in November 2003. Among the objectives of this workshop was to experiment, and later to evaluate with teachers of the earlier series of school, the EdaDe (Education through Design) proposition applied to the Brazilian case. The workshop was offered in the Visual Expression Department, campus of the Federal University of Santa Catarina. The procedures adopted and some results obtained in this workshop are shown and described in this paper.

The Education through Design proposal

The EdaDe – Education through Design (Educação através do Design) proposal was developed in a PhD Thesis presented in 2002, by the designer Antônio M. Fontoura and tutored by Alice T. C. Pereira, in the Production Engineering Postgraduate Program in UFSC (Fontoura, 2002). Since then, it is growing thanks to the efforts undertaken by enthusiastic researchers who want to diffuse it. The issue presented here is justified due to the needs of continuation and improvement of EdaDe proposal through experimentation.

The activities were given to primary teachers from Florianopolis City. Truly, the EdaDe assignments are created for children but, so that they are carried out and applied correctly, it is necessary to develop the knowledge and understanding of the teachers. Actually, only in this way, the pedagogical objectives can be reached.

The first step towards putting into practice the proposal, that is still unknown in Brazil, was to clarify the project with the professionals (in this case the primary teachers) who will make use of it. Therefore, main objective of the workshop was, through a practical and reflective exercise, to prepare teachers for the practice of EdaDe.

The workshop profile was designed, considering its audience: teachers from public and private primary schools with different academic backgrounds. Working with a diversified group became possible to promote an exact understanding about the effects and the results from the workshop application.

The issues to teach in the workshop were chosen taking into account the demands and needs of the group. An important thing observed is the vocabulary used. An accessible speech was used because the group hardly knew anything about design and technology.

The workshop

The workshop was accomplished in November 22nd, Saturday morning and afternoon, in the Visual Expression Department building at UFSC – Federal University of Santa Catarina campus. The participants' group was composed of nine invited teachers from Florianopolis area and six organizers. Among the organizers* were two architects, an educator, two designers and a scholarship student.

The workshop organization was developed, taking into account that this occasion would be the first contact of teachers with EdaDe. Practically all of them were not familiar with the design basics or EdaDe. Knowing this, the session was divided in two main parts. The first one refers to a theoretical explanation about design and EdaDe presented in the following sequence:

- What design is;
- How designers work;
- Something about design methodology;
- What EdaDe is;
- Why we must adopt the EdaDe, and
- How we can put in practice the EdaDe in our primary schools.

In this part, some general pieces of knowledge about design and ways adopted by designers to solve problems were presented together with some examples of good design.

Figure 1 – EdaDe being exposed

The second part was a practical experience. It was promoted through the execution of small tasks and fast exercises by the teachers, under the tutors' supervision. After the accomplishment of these activities, a simple problem of design (a design brief) was placed and some tools and supplements (cards, paper, glue, etc.) were available. Using what was presented during the first part of the workshop and the conditions offered in the second one, the participants looked for appropriate solutions.

Knowing the Design

The first part was divided in three modules with the objective to teach teachers about design and about the designer's activities. In this way, we hoped that the teachers learned something, even if it was superficial, about design. We showed and emphasized the importance of the design in our daily lives and how design and designers get better and facilitate our lives.

Actually, we tried to provide a clear and objective view about design and its areas. We tried to make the teachers aware that design is something present in their day-to-day lives. We emphasized that some people are professional designers (they studied in specialized schools to be designers) but in a general way, all of us are designers. Everyday we answer questions and solve problems related to the design. Everyday we make aesthetic choices and give form to our ideas. We materialize concepts. We transform ideas in forms. Daily and intuitively, all of us make design. In this part of the workshop, we tried to break some myths and offer some consistent knowledge.

Really, in several moments we adopted a generalist posture and intentionally we left aside some specific considerations about design. We thought the more important was to give them a holistic view of design.

Some things and thoughts about design were shown trying to connect them to EdaDe. In the EdaDe context we highlighted: "teachers can and must use design activities in their classrooms. Everybody always use design skills when trying to create or improve their life conditions. We all are designers".

> *"Every human being is a designer. Many also earn their living by design – in every field that warrants pause, and careful considerations, between the conceiving of an action and a fashioning of means to carry it out, and an estimation of its effects"* Potter, 1980 p.13).

Beyond this, we used examples of designed products as didactic resources, such as products of daily use including toothbrushes, balls, shavers, corkscrews, pen, pencil and bottle-openers – we set up collections of objects. In spite of the teachers being

Figure 2 – Daily objects used during the first workshop part.

unfamiliar with the problems of the world's industrial production, was shown to them that we live and interact with designed objects every time and everywhere and those objects were designed by somebody, sometimes like us. Then we can say: the design is in the bed that we sleep in, in the clothes that we wear, in our kitchen appliances, in the streets of our city, in our toothbrush, in the stapler that we use, in our classroom, in the chair that we sit, in our home; in everything and every place around us.

Some knowledge and information related to the theme of the second workshop part – design of vehicles was presented.

Understanding EdaDe

To talk about EdaDe became more evident. After the design was presented and argued, we showed the teachers the basis of EdaDe. The meaning of EdaDe was presented to the participants, the relations between design and education, the pedagogic basis of EdaDe, the educational benefits generated by EdaDe, and the way that EdaDe could be used in the classroom.

We tried to show how the connection between mind and body, brain and hands, action and thought, can be promoted and motivated by design activities in the primary school.

The main kinds of design assignments that could be used by teachers and the design skills that they could develop with their children in the classroom were also addressed.

Time to try

After the brief theoretical contact with design and EdaDe, the teachers switched to the practice. The second part of workshop was dedicated to the practical exercises and experimentations. They were invited (challenged) to design and make a vehicle, using the resources (scraps, paper boards, wood axles, etc.) existing in the workshop room. The tutors explained and gave some clues to use the tools and materials; they showed ways to connect the wheels to the axles and the axles to the chassis. It was suggested to the teachers that they should try to act and to think as if they were children (trying to play as their children).

Initially, the participants' group was divided into smaller groups (two or three persons) so that all had opportunity to manifest their ideas and thoughts. During this process we were able to observe some skills and abilities demanded, among them: creation, imagination, visualization, oral expression (argumentation), coordination, negotiation, logical reasoning, lateral thinking, modeling, etc.

It was explained that the process was more important to be valued than the end product. In this moment, we emphasized the importance of the creative and the planning phases, avoiding emitting judgments about the resultant objects. We reserved for later any other judgments. In this way, we were trying to promote the cooperative work, not the competitive work.

Some questions were used to motivate the reasoning and thinking in this initial phase: What is a car? What is a vehicle? How things and persons could be transported or moved? What is necessary to make a vehicle? What is essential? What is superfluous? Are the wheels necessary? How many wheels should be used? How should the wheels be? What should the distance among the axles be? Should the axles be parallel? And what happens if they are not?

Having thought about these considerations and questions, the groups began to create and develop theirs ideas. Initially, the teachers conceived the first concepts by drawing. The concepts were analyzed. They chose and selected the scraps, materials, tools and equipments available, and began to make some preliminary models. They tried some constructive systems, and then each group could verify the more viable technical solutions. Then, they re-evaluated their initial concepts and made some changes in the models. Before the construction of a definitive model, they planned the way forward. They elaborated a plan, step-by-step.

Figure 3 – Teachers choosing materials to make models

We were able to observe that the motivation and the teachers' enthusiasm were maintained during all this work section.

Once the model making phase was concluded, the solutions were compared to each other. All teachers, together again, analyzed the vehicles designed and made by the smaller groups.

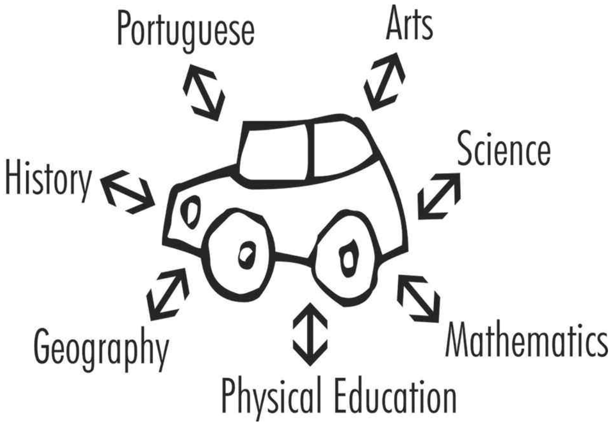
They tried to identify some criteria and parameters to evaluate and to analyze the vehicles such as: weight, measures, functionality, appearance, etc. (some of them more objectives other less). They classified the models by those criteria and parameters and some order was established. For instance: from the smallest to the largest; from lightest to the heaviest; from the fastest to the slowest; from longest to the shortest, etc.

Figure 4 – Teachers classifying the models

They tried to identify which was the most beautiful, the better built, the more drivable, the most resistant and the most functional one. The diversity of parameters analyzed gave chances to all of them to be important in some way.

After having finished the models analysis, the teachers began to discuss some ideas and thoughts; they tried to identify which skills were worked and which other subjects and knowledge areas (Mathematics, Portuguese, Science, History, Geography, Arts and Physical Education) could be linked during the activity. For instance: in Portuguese, they can extend children's vocabulary, including new words and expressions; in Mathematics, they can teach measurements systems, calculus and proportion; in Science, they can show some things about mechanical systems and materials; they can still explore the ecological issues; in Geography, they can study the country adversities that the vehicles must surpass; in another hand, the importance of vehicles and transports for the regional economies; in History, they can explain the origins of automobile industrialization; etc.

Figure 5 – Connections with others knowledge areas



In the end of this part, we made a general evaluation of the event. We asked the teachers about their impressions and feelings. Besides the direct observation of the teachers' behavior during the accomplishment of assignments, the evaluation was very important in order to get significant and conclusive pieces of information.

To conclude

The experience and the construction of new knowledge promoted by the workshop were found to be very satisfactory both to teachers and to organizers. We were able to try some theories, preconceptions and ideas that we had about EdaDe, some of them were proven and others were refuted. We can affirm that the workshop allowed the confirmed the educational basis of EdaDe and its pedagogical potential. The assignments accomplished during the workshop, animated the participants and they demonstrated a high level of satisfaction. We cannot affirm for sure if the main objective of workshop was accomplished but several things indicate that it was. Some teachers are using the EdaDe assignments in theirs classrooms already.

Certainly, several things must be improved in the next workshops. Among the improvements we should: distribute better the tasks during the time; improve the quality of the texts worked; and improve the contents about design and technology.

Figure 6 – The participants' group

We could observe that the teacher is an important element in the implementation process of EdaDe in Primary Schools. Formally, as a content in the syllabus or as a complementary pedagogical activity in the school, teachers are the main responsible for the EdaDe success.

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* Organizers

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- Renato Bordenousky Filho – assistant (PUCPR / CEFET PR);
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The Impact of Home Languages on the Teaching of Design and Technology in Schools in England

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Abstract

Over the last twenty years there has been a marked increase in immigration from outside the European Union, as well as some internal movement between borders. Children from countries as diverse as India, Albania and Saudi Arabia have arrived with their parents to be educated in British schools. The progress of these children has been affected by their ability to understand the English language. Often the child has to decode the teacher's language before they can begin to complete the required task. These children are perceived to be of low ability, and yet they are often bilingual or trilingual, but need to come to terms with a new culture and language. The language spoken at home is known as the home (or heritage) language as a means of separating it from the language taught at school.

There is anecdotal evidence to suggest that children who are not fluent in English, do have lower attainment in schools. The aim of this project was to assess the validity of this belief in the subject of design & technology, in one school with one year group.

Introduction

> *"Educational inclusion is more than a concern about any one group of pupils… its scope is broad. It is about equal opportunities for all pupils, whatever their age, gender, ethnicity, attainment and background."* [1]

Achievement of minority groups

Considerable research has identified a range of factors that affect achievement in minority groups:
- Social deprivation
- Isolation
- Mobility
- Teacher expectations
- Length of settlement and period of schooling in the UK
- Parental education and aspirations
- Fluency in English
- Special educational needs
- Exclusion
- Institutional racism

Research from OFSTED between 1998-2002 has identified that children with English as a second language are served best by schools that have:
- Strong leadership
- High expectations for their pupils
- Show effective teaching and learning
- Affirm an ethos of respect, with clear policies on racism and bad behaviour
- Seek parental involvement

> *Making genuine links with local communities and involving parents can be exceptionally difficult, but appears to be a key factor in supporting and extending successful change".* [2]

Legislation such as the Race Relations Amendment Act 2000 and Learning for All, CRE 2000 have reaffirmed this belief.

> *"A particular strength of (successful) schools is their communication with parents".* [3]

There are four main barriers to learning with minority ethnic pupils:
- Language
- Gender
- Stereotypical views of both community and schools
- Fear of the known and the unknown

Some Local Education Authorities have more minority ethnic pupils in their catchment areas, than others and this project was based in the Sandwell Education Authority.

In Sandwell, white British pupils dominate schools overall, but other groups are also well represented. Asian/British Indians allow for 11% of the total, with 6% Pakistani and 2% Bangladeshi. The stereotypical view is that all Asians speak the same language, but this is not the case. Muslims use Urdu as their home language, Sikhs and Hindus speak Punjabi and Bangladeshi families use Gurjarati.

The Sandwell Local Education Authority figures reveal that they have children from 30 different countries in the area. They do not have teachers capable of speaking all those languages. They do not have translators either.

The project

Two specific schools were chosen for this project, to enable a comparison of data. These schools were chosen because of data provided on their PANDA report and information from Sandwell Council.

They were:
- Victoria Park Primary School, which caters for children with 23 home languages.
- Lodge Primary School with a large Bangladeshi community that is atypical in Sandwell overall.

Individual schools provided data about the ethnic diversity of their classes, based on their returns to Sandwell for the purposes of monitoring children supported by EMAG funding.

Victoria Park Primary is a large four-form entry school in East Smethwick, close to the border with Birmingham. The school is rated with an E* on its DfES PANDA report which means that the school consistently achieves SATS results below the national average. Victoria Park serves a large multi-cultural community including Sikhs, Hindus, Muslims and Christians.

With 31.4% of the total number of children in school, the Muslim community represents the largest ethnic group in the school. It is comprised mainly of families that emigrated from Pakistan originally.

In the school, Muslims use Urdu as their home language, Sikhs and Hindus speak Punjabi and Bangladeshi families use Gurjarati. Afro-Caribbean families use Patwa. The school has two teachers who can speak Punjabi. No other home languages are represented.

Lodge Primary School is situated five miles away, also in the Sandwell Education Authority. Situated close to West Bromwich High Street it serves a community which is predominantly Muslim.

The community around Lodge Primary comes from Bangladeshi extract and uses Gurjarati as their main home language.

The project intended to choose a group of children working in an Eastern European home language, who could be taught in their home language. However, finding a teacher/translator in this language proved impossible, with the Local Education Authority being unable to provide a teacher who spoke Polish, Serbian or Hungarian.

Despite a request by the Equality and Social Inclusion unit, a Gurjarati or Urdu fluent teacher could not be made available on the dates of the project, so a teacher who used Punjabi agreed to volunteer and taught her part of the project in both Punjabi and Urdu.

Teachers in each school were asked to complete a voluntary, confidential questionnaire about the children in their class.

Results of the Questionnaire:
Rankings of subjects that teachers believed minority ethnic pupils found the hardest:

1 Literacy
2 Numeracy
3 History
4 Music
5 Geography
6 Religious Education
7 Design and Technology (D&T)
8 Art
9 Physical Education

Levels of achievements:
60% of teachers believed their pupils were working two levels below the national standard average ability level for their children.

Design & Technology
80% of teachers stated that children could participate in D&T projects by observing peers and copied them in practical tasks. However, any skills that involved literacy and Numeracy saw the same problems replicated as they found in Literacy and Numeracy lessons.

Two control groups were established for the project. One group would be taught in Punjabi. The other group would work in English.

The children would undertake some of the stages found in the QCA Scheme of Work 'Moving Monsters':

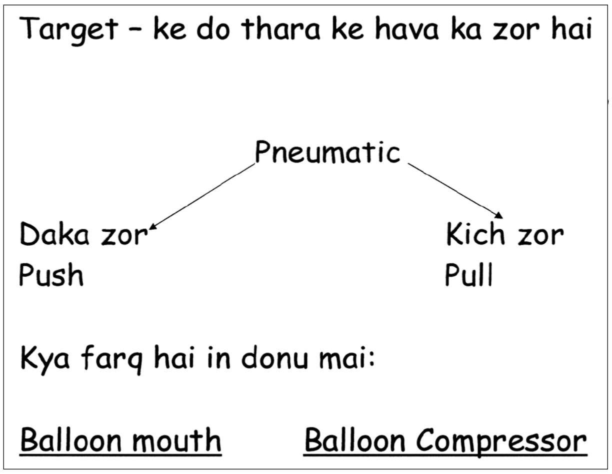
This included:

- Undertake research into air-powered mechanisms.
- Compile a risk assessment for using air power.
- Complete a Focused Practical Task to construct a circuit to open and close train doors, by following a schematic diagram.

This Scheme of Work was chosen, because it contained subject-specific vocabulary that the children would not have experience of using in either English or Punjabi.

The words that were highlighted to be used were:

- Pneumatic
- Compressor
- Oxygen
- Pressure
- Hydraulic
- Circuit diagram



The children were chosen using the criteria that they all spoke Punjabi as a home language, and were all nine years old and working at level two, according to QCA D&T guidelines. The results were compared and analysed.

The pupils were given a proforma to record their work. They were also interviewed before and after the project to assess their views on the topic.

Mrs Chand taught Shahrukh, Akib, Rizwaan, Taiba, Sabha and Abbas.

Mr Perry taught Usmaan, Janed, Saiba, Isaac and Haroon.

A Scheme of Work was provided in English and Mrs Chand made notes to help her teach in Punjabi. See Appendix I. These notes revealed that the chosen subject-specific words were not easily translatable into a home language with Mrs Chand choosing instead to use English as a language. See Appendix II.

The Scheme of Work as taught over one day on Tuesday 27th January 2004. The timetable was as follows:

09.30	C Perry and M Chand meet to discuss the project.
10.30	M Chand teaches her group the theory of pneumatics, observed by C Perry.
11.30	Practical task
12.30	C Perry interviews M Chand about the session.
13.30	C Perry teaches his group the theory of pneumatics, observed by M Chand.
14.30	Practical task
15.30	M Chand interviews C Perry about the session.

Observations about the project

Both control groups showed no marked difference in concentration. The children were stimulated by the project with lots of questions and a natural excitement to quickly complete the task. They were enthusiastic to answer questions but often got the answer wrong.

In both control groups, the children chose to write and communicate in English.

> *"I don't know the words in Punjabi"*, Akib.

> *"I can't write Urdu or Punjabi"*, Saibha.

> *"I can't write or read Urdu, my parents only speak it at home"*, Usmaan.

Specific subject vocabulary proved to be very difficult to translate into Punjabi, and words such as 'pneumatic' were identical in both projects.

Mrs Chand described her description of these words as 'English as you would say Punjabi'. In Punjabi she translated the words telephonetically to aid understanding so the children could hear the sound of the words, but were unable to decode a meaning.

Children in both groups learnt most through touch. The opportunities to explore practical objects such as a balloon pump or foot pump provided a source of great discussion. When asked to write a list of air-powered objects most preferred to draw the objects and could only add the names when prompted with a vocabulary list.

Seven of the children in both groups observed their peers and copied the work of two children (one in each group) who were able to read and write bilingually with more success.

The colourful circuit diagram proved straightforward to read, but the instructions to measure the correct lengths of tube (written in Punjabi for one group; English for the other) were not read and children invented their own lengths.

> *"I can't read the words, I speak Urdu but can't read it"* Abbas.

> *"At the mosque we are taught the Qu'ran in Arabic, not Urdu"*, Taiba.

Children in both groups observed that they could not read Punjabi or English.

Children observed that they speak a regional dialect of Punjabi that is not shared by all Punjabi speakers. The teachers used in the project were from the local area, but their regional accent still prevented children from accessing their spoken Punjabi.

Certain telephonetic sounds, particularly trigraphs, are not shared by all languages and this inhibits learning.

Attainment in both groups was not limited on a practical level, but any form of task involving writing caused problems in both languages.

None of the children could write Punjabi, but also did not know how to write the English words with confidence either.

Future research issues for teachers

After analysis, the data collected from teacher's questionnaires confirms that children who are not fluent in English do have lower attainment in classes. In academic subjects attainment is lower, when compared with practical subjects such as D&T, Art and P.E. where children use pedagogical skills and can observe peers easily.

In a class where children can have four different home languages, even an attempt to explain the task in English and another home language would still leave over 50% of a multi-cultural class without a method to access these languages. To teach all the children in one class alone – 65P, my class – using home languages would require a translator for four different home languages, which is not practically possible.

Further research could suggest whether home languages may share certain common words and sounds that may aid understanding and enable a limited sharing of vocabulary.

Future issues for schools

Schools place children in classes according to age of entry. If schools were to consider placing children in classes according to their home language or home language/ability level in English, then it may be possible to teach classes bilingually in a home language and English.

At Victoria Park Primary, children are placed in class by age of entry, but they are withdrawn for Literacy and Numeracy lessons and taught in ability groups. The teacher in this class speaks only English, but her teaching methods have been more effective than Lodge Primary School where children have targeted support of one hour per week.

Outstanding questions

At a national level, there is recognition that the English curriculum is enriched by the diversity of culture and language that helps children to understand the wider world.

The Ethnic Minorities Achievement Grant provides financial support to schools to employ Learning Support Practitioners, but there is no provision for the widespread use of translators and bilingual teachers. Schools with a high percentage of bilingual children would benefit from finance to employ their own translating staff.

There is a plethora of ICT-based teaching aids now being created, but only in English. Could providers of D&T software be persuaded to provide versions in other heritage languages as well? Let the debate begin…

Notes

[1] Evaluating Educational Inclusion: Guidance for Inspectors and Schools, OFSTED 2001.

[2] Research on the Achievements of Minority Ethnic Pupils, OFSTED 1998.

[3] Achievement of Black Caribbean Pupils, OFSTED 2002.

A Laptop for Each Pupil: An Analysis of Technology Education Teacher Activity

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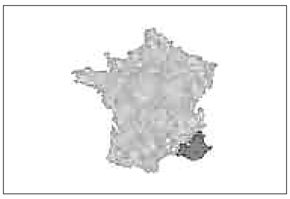
Abstract

This communication proposes an analysis in education technology teaching in France for 13 years old. Laptops are entrusted to each pupil and to each teacher personally. This equipment policy from the local administration (lending computers to pupils) is imposing on the principal actors of the education system without teaching accompaniment or teacher training. This situation gives to the teachers freedom and offers to them the possibility to use or not to use laptops. It shows, for those which make the decision to integrate into this use their work the problem that arise. The analysis of the first use in the classroom by a technology teacher is used as field of practice observation. The modifications of the teacher's work and what on the contrary is not modified consolidates what the preceding studies as regards education sciences show concerning the role of the teacher.

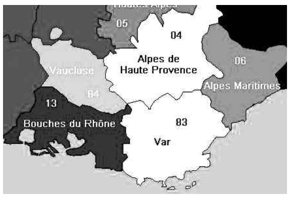
Introduction

The use of equipment called "Ordina 13" carried out by the local administration (Conseil général des Bouches du Rhône) (Photo 1) gives to the technology education teachers, as all others, the possibility of using laptops in 4e and 3e levels for approximately 13 year old pupils in the area (Map 1 and 2). In fact each pupil has personal equipment that makes it possible for the teachers to request its use in their teaching. What is described previously as just a possibility, in reality offers new teaching conditions through this massive introduction of laptops. This policy gives equipment but without support and pedagogical target (i.e. no accompanying suggestions or teacher training). Of course, the political context of this deployment means an aim to reduce social inequalities without giving teachers guidance as to how to use and integrate them into their teaching. What the teachers can or must do exactly is in the experimental phase for those who decided to try to integrate it into their teaching. Some chose not to seize this opportunity. For us, this introduction into teachers' practices seems interesting to study within the framework of the technology education teaching.

Conseil Général des Bouches du Rhône building



Location of area Provence Alpes Côte d'Azur in France

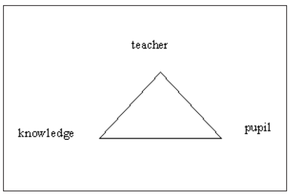


Location of Bouches du Rhône in the area Provence Alpes Côte d'Azur.

Theoretical Framework : Instrumented Activity and teaching situation in teacher labour

For various authors the instrument covers the different characteristics which have as a common feature to grant to him/her a place of mediator between the subject and the object. Simondon (1989) proposes what the technical system makes it possible to do. The tool and the instrument would be, by biological analogy, like effector to carry out operations (tool) and to take information as our senses perceive (instrument). In that case the operative system could replace the subject activity like Deforge (1985) shows it in evolutions lines. The object includes more and more operations. But Rabardel (1995) defines very precisely the instrument and for him it is not only material. During the activity the artifact becomes a real instrument in relation with the subject action. For this author, the artifact becomes an instrument in the use. In reality, the artifact constitutes only one part of the instrumented activity; the other part concerned with the own user contribution. Thus in any instrumented activity, the subject rebuilds for itself the intellectual process for using an artifact during a significant activity for him/her. If action requires mediatisation of an artefact, Rabardel speaks about instrumental genesis. An artifact is not in itself an instrument nor even a part of an instrument (even when it was initially conceived for that). It is instituted as instrument by the subject that gives him this statute by achieving the goals of its action. The instrument is a mixed entity made up of the artifact and intellectual process which the subject associates with it. Rabardel distinguishes in the instrumental genesis the instrumentalisation process (related to the artifacts) and the instrumentation process (related to the subject and its activity). If a teacher integrates in his/her teaching conditions pupils' laptops, the question of what he/she does or what he/she wants to do is interested in the teaching-learning situations.

The teaching situation is central in teacher occupation. What it does in the phase of preparation or the interaction of the class is influenced by various factors. The finality of its action finds its realization in situations about knowledge transmission-appropriation. The tertiary relation (Figure 1) teacher-pupil-knowledge (Johsua, Dupin, 1993) appears in the teaching situation.



The relation teacher-pupil-knowledge

However real situations are complex situations (Devolvé and Margot, 2001). Participation of the teacher can go from one extreme to the other. Some situations come from completely external contributions that the teacher adapts because the class management depends on him.

The effective realization plays an essential regulation role for teaching. Teaching starts from a project which anticipates the desired activity of pupils. This activity has not only repercussions during the meetings concerned. The pupils' activity is organized with an aim of modifying or of founding a new relation with the worked or studied objects. Ultimately consequences of teaching situation and pupil activity follow a learning aim. The teacher envisages introducing in class, a material and temporal organization in which it seeks to find a specific relation to an object. With the situation provided (documents, materials, groups etc.) the teacher organizes study conditions (Johsua, 1998, 1999) and gives these to the pupils, pre-empting pupils' action. The artifacts which it is given to teaching and learning, the instrumentalisation associated are in fact pupils' activity condition.

Observation from research

Some didactical concepts make it possible to explain teaching situations and transmission appropriation processes which are played out in these situations. But which are the educational modifications, which the new material conditions due to the lap-tops? What modifications are made to the teaching? What are the teaching practices which change with the introduction of the lap-tops and which of these lead to modifications of material conditions at the educational or pedagogical level? What are the changes which take place on the nature of teacher labour? Are the concepts of the didactic part of education science directly in relation to the work of the teacher called into question or remain valid?

From all these questions, direct answers will not be found, but explanations are beginning to be sought.

To observe the particular change situation initiated by an external contribution, it appeared useful to neutralize all possible variables and to take into account knowledge in an already known field of research. The technology education teacher observed has been teaching, tested and working for several years in an establishment considered difficult. Computers are considered useful in his professional practice (in his preparations and in class). We have observed situations in which the teacher has decided to use lap-tops for the first time. The observation of the first two meetings made by this teacher, who used the lap-tops in class, was made through video recordings and the retranscription of speeches during four meetings.

The analysis "a priori" (Salin Mercier, 88) made it possible to keep up to date with the intentions of the teacher and the tasks planned for the pupils. Consequently, comparison could be made between the observation of the meeting and the teaching envisaged. The meetings observed related to work carried out within the framework of the preparation of pupils' assessment.

As the main teacher of the team, the teacher had envisaged a realization about the presentation of assessment of each pupil. He would have, in any event, accomplished it with the fixed data-processing equipment. The teacher wanted to give responsibility to the pupils for their own assessment.

Some results

At the time of the observation the total deployment of the operation "Ordina 13" was not finished. More than one year after the beginning of this operation the connection to the network is still not operational for all the colleges involved. A project of such a scale requires time for the whole implementation. However after distribution of the lap-tops to his pupils, the teacher observed decided to integrate them into the school work even without connection to any network. Many problems arose relating to the files. To cure it, the teacher communicated his documents on CD and recovered the files of the pupils on USB memory flash. During the second meeting, this led to many concerns about where files could be found. Comments such as:

> *"Does somebody have my key USB, there?"*
>
> *"My stick!"*
>
> *"Which has my key USB? Ah it is you... I can remove it?"*

This experiment in the handling of the files enabled him to adapt to the situation of no network. But the practice of the handling of the computers in class is modified by the spacial organization of the class. The pupils are sat in their places with their lap-tops as with their books. However, the teacher was accustomed to see visibly all the screens in a computer room and to quickly take information about the work of the pupils. With the lap-tops he does not see the screens except if he moves around. On the other hand, he can use the video projector to make live the common interest and manage the collective dimension of the school work, just as he might when using a blackboard. He asks particularly at the beginning and the end of the lesson to close the lap-top, to not look at the screen but to look at the teacher and to be attentive to what he says. The second meeting starts in this way:

> T (for Teacher): *"You close the lap-tops and you note on your notebooks that tomorrow I am not there. Mr. XXX absent, I am on a training course."*
>
> P: (for pupil): *"you said it already!"*
>
> T: *"I said it but you did not mark it, and if you need to leave, especially at the end of the day, you require that it is marked on the notebook. Thus note it: absent on December 2. I am on a training course for the day, I could not be there. Today it is the penultimate hour, since we still have an hour next Monday, and in the afternoon it is the council. (to a pupil) You close the lap-top!"*

After 2 minutes :

> T: *"Then others... (addresses itself to a pupil) Lap-top, lap-top! The lap-top, hello? not, you cannot listen there, you cannot be there..."*

After 8 minutes :

T: *"(speaking to an unruly pupil) Close your lap-top, you ! I listen to you... How does one open a file on a CD? I listen to you! Go! You want to recover your photo, how do you do it?"*

P: *"I did not do it. I did not do the photo!"*

T: *"You did not do it? Yes, that's certain. You will recover the logo?"*

T: **"***How will you do it?"*

P: *"I do not know."*

T: *"You do not know? It is normal, you don't listen to me... You cannot know! Well... Who can answer? (a pupil raises the hand) I listen to you XXX..."*

After 48 min

T: *"look at me! Close your lap-top ! You do not speak to me like that... We are not friends! Chut! At least XXX, before eight days of the assessment council, you are right... If there were doubts, at least there is not more! You really understood, there, the strategy?..."*

The teacher must focus attention and wants to ensure that nothing prevents the pupils from concentrating on what he says. He asks them to shut the lap-top as he would ask them to close the book. However the lap top may be more attractive to the pupil than the book. Taking into account this attractive aspect, one feels that the teacher deploys an unquestionable energy to centre the attention of the pupils on the activity requested even if the risk which it takes to unbalance the situation of teaching by modifying his organization is minimized by the proximity with what it would have envisaged to do on fixed stations. The knowledge relating to the work requested from the pupils contributes to the realization of a diaporama of three slides with insertion of objects (photographs, tables, graphs...) for the presentation of the individual results at the time of the assessment council. The management of the files, of the recordings, function copy-to stick it should be acquired from level 6 (two years before). However, in 4th level many of the pupils seem to have difficulties, that makes the teacher reconsider basics by pointing out technical principles:

T: *"Before copying an object, it should be selected, whatever the object! An image, a text, a table... if you do not select it, then it cannot be used..."*

The lack of practice/knowledge is not new. But the teacher is surprised:

T: *"XXXX, I feel that there is a small fall in the intensity of the work... It is a pity because one can see the end in sight this week. It is true that we had to hurry some of the work, and maybe I did not insist enough on certain things. There are operations which I thought that you could do and that you do not manage to do... For the next week... XXXXX you look at me... Miss YYYYY you you listen to me..."*

The appropriation by the pupils

If computers traditionally used in technology education were not the only computers to which pupils could have access until now, the computer is not any more the only working tool which is used to carry out what the teacher requires. The pupil carries it with him/her and can use it freely, even if it does not have all installations/programs. That becomes a personal object whose appropriation will also pass by an instrumental genesis for him but the objectives will not be teaching. The majority of the pupils had personalized their screen at the first meeting and on several occasions the teacher asked them to stop the music that he had not requested. Another aspect-during the meetings, the pupils carried out the work requested by the teacher as with any school device. At the second meeting two pupils forgot their computers. For the teacher, this lapse of memory is as with any lapse of memory for any school material.

T: *"XXXX, people who do not have the lap-top, there, I realize that when you do not have the lap-top, approximately, I will not accept you in progress any more because you are embarrassing for the group. You do not have a lap-top, therefore you do not have anything to do... XXX I speak to you! You understand ? It is clear ! Thus the next time, it is like the school material... No book, no material, no course!"*

The teacher activity

The teacher tries to juggle between whole class teaching and individual assistance where things appear much clearer and are usually quiet. But in fact the instructions given by the teacher guide the work of the pupils like before. So that the pupil learns and engages in a task which he/she does not control yet, the interaction with the teacher is crucial. During the second meeting the teacher uses a didactic strategy so that a pupil who has problems saving a document, recovers his file:

P: *"You, you did not make the photograph? Go I take a photo of you there... But the photo is for you, I do not want it."*

While undertaking this, it encourages the pupil to find a solution to save his/her photo.

Conclusion

We cannot speak really about a final result from the research but the first observations can appear relatively precise and paradoxical compared to the very broad field of observation. But this first approach reveals indeed the difficulties which arise when inserting in practices, a tool, whose efficiency and pertinence is less obvious than it appears compared to the instrumental genesis in the activity concerned.

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Using Artefacts and their Stories to Develop Design and Technology Capability

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Abstract

This paper describes a collaborative project, funded by the World Wide Fund 'Partners in Change', through which student teachers explored the use of artefacts and their stories to stimulate design and technology activities. The aim of this project was to increase the skills of student teachers in the use of artefacts with a global dimension. In addition, an aim was to take the college based work into the classroom to increase the quality and effectiveness of the use of artefacts in design and technology education and to incorporate a global dimension into the student's planning and delivery. Projects with children, carried out during the students' school experience placements were monitored to attempt to assess the impact the use of the artefacts might have on the students' planning and teaching as well as reflections in the assessed portfolio.

Introduction

Alongside changes to the BA(Ed) degree at Goldsmiths', University of London, England, brought about by the need to be compliant with the Teacher Training Agency Standards for ITT (TTA 2000) the opportunity to rethink the content of the second year design and technology option presented itself. Much of the existing course had been absorbed into a newly formed first year optional course, largely 'hands on', skill-based experiences of working with wood, plastics, textiles and food materials. This allowed the development of a more in-depth experience of designing and making for the second year students in preparation for those who wanted to take the third year specialist course or those who wanted to develop their practice with their specialist age phase.

With support from the WWF 'Partners in Change' funded projects (Griffin et al 2002) education for sustainability through design and technology education was embedded in introductory courses for both undergraduate and postgraduate students in initial teacher training at Goldsmiths. This had, however, led to what had been a substantial part of the second year design and technology option being reduced to one hour of activities and discussion. Through collaboration with Barbara Lowe from the Reading International Solidarity Centre (RISC) artefacts were used as both a stimulus and 'stepping off point' for the second year students to explore designing and making. This project, which started in September 2003, was a development of previous initiatives reported on in Teaching for a Sustainable Future (Griffin et al 2002) and at CRIPT 2003. The project allowed the student teachers access to a range of 'handling collections' of artefacts to analyse and evaluate. More importantly, it allowed them access to the stories behind the artefacts, those who had made them and why.

Theoretical background

One of the most significant premises of the original Partners in Change project based at London South Bank University and Goldsmiths' College was that design and technology was one of the subjects which have an explicit requirement or potential for a direct sustainable development education (SDE) content focus alongside geography, science and personal, social and health education / citizenship. (Inman 2002 p11). Inman also recognised that "all subjects have the capacity to foster SDE through promoting *teaching and learning processes* that foster specific skills and values" (Inman 2002 p12). The approach taken in this earlier work was to use product analysis to promote these teaching and learning processes within the design and technology courses.

In her rationale for the crucial role that design and technology has in preparing young people for responsible citizenship Conway uses two terms to identify this – 'technological sensitivity' and 'technological literacy'. Technological sensitivity was identified by the Scottish Consultative Council on the Curriculum (SCCC) in 1996 in Technology Education in Scottish Schools meaning a 'caring and responsible disposition', and a 'habit of mind' which questions and reflects, not only on technical and economic but also social, moral aesthetic and environmental questions (Conway 1999). Olson, Conway tells us, wrote of the need to retain technological literacy to its more "humane, more socially orientated role". (Olson 1998) Conway suggests the use of audits carried out by companies to help develop young people's understanding of the 'real world'.

Companies which are household names contributed to the 'Products and Application' Conference in 1995. This conference led to the publication of the booklet 'Looking at values through products and applications', in which, headings are suggested to list the values influential in the development and use of a product (DfEE 1996). These include technical, economic, environmental, social, aesthetic and moral values. In evaluating feedback from teachers as a response to this booklet Martin addressed the issue of evaluating products when he suggests that an important part of technological literacy is looking at values within products and reflecting on the effect that products will have on people and society and how they are valued. (Martin 1996 p4).

Ten years on we are being offered opportunities for change in the way we organise the curriculum in England. In September 2004 the Primary Strategy was adopted offering perhaps more creative approaches to organising the primary curriculum. This should provide more cross curricular opportunities including linking design and technology with subject like geography and citizenship (DfES 2003). A potentially more radical change, however, is being proposed with the publication of the pamphlet QCA Futures: meeting the challenge and the various consultative and debating forums. Now, global education is coming to the fore with the 'increasing international dimension to life and work' identified by the QCA in the pamphlet as the fifth force for change (QCA 2005).

The artefacts

The artefacts, all from countries of the South, were loaned from the collections at RISC, and were chosen by the authors because they would challenge stereotypical or negative views about those who had made them, the countries these people live in as well as supporting the development of design and technology activities. Two lengths of Adrinkra cloth together with several calabash printing blocks were supported by a poster explaining each symbol printed on the cloth. On another poster were photographs of a young boy from Ghana showing the process of making the tin car also provided within the collection of artefacts. A 'push along' bird, made by a child in Kenya offered the students a toy, interesting technologically as well as for its story. The third pair of artefacts comprised of a hand and a shadow puppet, both from India. Within the collection, on loan from RISC, were books on toy and puppet making, and the children's story book, 'Aani and the Tree Huggers'.

Methodology

The students were asked to select one of the artefacts and identify questions they could ask of it. These questions were organised and developed through using the Development Compass Rose, originally developed by Teachers in Development Education (TIDE) in 1995. The students were then given the information and asked to research using the books available and the Internet. Designs for the first design and make task were based on the chosen artefacts. As the course progressed the students compiled resource packs to support this activity. During their school experience placement the students were required to teach design and technology. This was analysed and discussed in their written assignment.

At each stage, that is after the first session, after the completion of the design and make task and on return from school experience, the students were given a questionnaire to elicit their response to the project. As with any intervention, the questions asked also supported the students in analysing the issues as they presented themselves. Feedback sessions with the authors were also used to monitor responses as well as supporting the students' understanding.

Responses to the artefacts

The students were initially intrigued and not necessarily aware of the significance of the artefacts. One student thought that they were "examples of children's work that Goldsmiths' students had brought back from teaching practice" while another thought they were great but thought that "they had been made by the children for the children and, on reflection, my opinions were possibly slightly patronizing". This student went on to explain that they had compared them with "with my knowledge of how children like making things – and thought that they would enjoy making them (more than playing with them!)". Some of the students found the artefacts interesting immediately while the interest of others grew as they began to identify questions "as by finding out more explained that it had more meaning than we first thought". Using questioning to explore and analyse the artefacts was also effective in developing their interest as evidenced by one student response "I wanted to know more about them, as we were asked to think of questions, which was then tempting to find out about the answers."

As the stories behind the artefacts were revealed the students started to examine their initial responses with some significant insights gained.

> *"I felt quite humble given that we are so lucky to have, at our disposal, materials and money to buy new resources as teachers, but could fail to achieve the standards of craftsmanship seen in the toys. Most upsetting was the link between the design and manufacture of the toys and the need for them to be commercially viable to satisfy tourists."*

The students who had chosen the toys to explore were particularly moved by the push along bird which, it had been assumed "they were making it in schools for themselves (to take home)". As it emerged the toys had been made for very different purposes. Both were made by children but one was made to play with, the other to sell to tourists to fund schooling. Feelings ranged from "I suppose I was slightly disappointed to find that they had been made as part of a business and that the end-users would be tourists" to admiration for the producers "made you think about the work that went into make them". One student expressed shock "because I would never of thought that children/adults made these toys for tourists" while another found that the information "prompted lots of thoughts about my own opinions".

The process of exploring before being given information was seen as a positive experience by the students with one student writing that they found it "fascinating, good to be able to compare what we thought about the puppets to where they were really from and made from etc" while another wrote "because it was given bit by bit, it made me more curious and allowed me to take in more information than I would have done if I had all of the information all at once". The information also seemed to have supported the students in asking more questions as well as giving further insights.

"The information answered the questions that I had about how the puppets had been made and why they had been made. Knowing more was helpful, I appreciated having greater insight."

The students who had chosen the Adinkra cloth to explore had no idea of the purpose of the cloth and its design until they had been provided with the additional information.

Efficacy of the approach

The artefacts continued to offer a positive context for the students' design and make projects with some very thoughtful and sensitive interpretations of the brief. Without doubt the artefacts had an impact on the student's approach to designing and making on the course.

The authors also wanted to see how this experience would impact on the work in school, particularly the use of handling collections of artefacts which were supported by research in the form of stories wherever possible. To appreciate how difficult it is to take this experience directly into the classroom it must be noted that with the National Curriculum supported by schemes of work students don't have the choice over topic for design and technology. Although the QCA are encouraging schools to explore alternatives to the units of work many are staying with what feels familiar. Timing is also an issue for students wanting to use their planning from the resource pack they had compiled. Some schools would have already started design and technology units of work before the placement started, other students will have little time to complete a unit started after the mid-term break. The responses of the students should be considered within this range of contexts where choice over what they experience is not always in the gift of the student.

Of the students who responded to the final questionnaire 67% reported that they had used handling collections / artefacts during their school experience placement to introduce their design and technology activity / unit of work. These collections ranged from " making instruments, the class looked at a number of instruments and analysed how they worked " to "toys from the nursery" and "a collection of puppets for the children to explore, touch and look at". Of the students who had used handling collections only 25% reported that these had a global dimension. One student, however, reported using puppets from different countries e.g. shadow puppets from Indonesia, hand puppets, water puppets from Bali etc.

The Internet was used by some students to offer a global dimension "… the others were just typical resources such as pictures (from the internet) on 'Homes around the world' which have a global dimension".

The authors then asked the students how important it was finding out about the people / children who produced the artefact to a) their understanding and b) the children's understanding. The responses indicated that there was a good understanding of the importance of knowing as much as possible "so you are confident in yourself as well as being able to answer children's questions" and helping the children develop their understanding "in that they knew why they were producing their own puppets, looking at how they could use then etc." One student who had used buildings as a topic felt that "without the material samples, the children would not have been able to understand differences as they had no tangible reference points." The student went on to write that if they had had examples of styles and materials of homes around the world this "would have extended their (the children's) knowledge, understanding and experience".

School based projects

Two of the students were able to use the chosen artefact throughout the three aspects of their course, i.e. the design and make project; the resource pack and the school based work. One student was part of the group of students exploring puppets. The hand puppet, made in Rajasthan, had been commissioned by RISC to represent Aani from the Jeannine Atkins's book for children, 'Aani and the Tree Huggers'. Taking inspiration from this the group used the central character in 'Handa's Surprise', by Eileen Browne to write a play and make characters, theatre and props. The student wanted to create his own enthusiasm in others and planned and very successfully used 'Handa's Surprise' in school. The puppets offered to the children at the outset of the activity were played with and discussed, although most of the issues raised were practical rather than cultural. It should be noted that the lesson took place during the final session on a Friday afternoon.

The other student used the same resources in school that she had experienced in college. The children were shown a poster of one of the boys in Ghana making his tin car which slotted together complete with suspension for the back wheels. It was clear, from her reflections on the subsequent design and make project, the impact the artefact had on the choices she made for this work. "I decided to do my project on moving vehicles". The car made by the young boy was "my inspiration and I took the shape, style of the car to support my designing". She goes on to report that "this reinforces my passion of having / using artefacts, as it develops knowledge and understanding but also stimulates ideas." She used a special collection of toys from India at the Museum of Childhood in Bethnal Green as part of her background research. The potential for cultural dimensions of design and technology was reinforced by this visit as well as the realisation of the impact that technology and its developments have had a major impact on the world.

The resource pack produced by this student built on the global aspects of toys from her reading and research combined with the experience of the toy vehicle from Ghana. This resource was used for teaching design and technology during the student's school experience placement using photographs of children with toys in different countries as well toys from the nursery class for 'hands on' exploration of mechanisms etc. The children in her class worked in pairs to produce vehicles using boxes, tubes and straws.

Conclusions

Although the funded project ran for one year the course has continued with a further cohort of students using artefacts within their design and technology course. A calabash dining set from Nigeria was added to the range of artefacts this year which offered the opportunity for looking at fireless cooking extending the students' experience into working with food. What has emerged from the initial project, taking into account feedback from the students at each stage is the need to use artefacts which have immediate meaning to the children. Through the collaboration between Goldsmiths and RISC sufficient information was available about the people who created or produced each artefact and the strategies used did not pre-empt curiosity and the ability to ask questions.

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Investigating the Value of Technology as a Catalyst in Developing Creative Thinking Skills in Young Learners

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Abstract

The paper outlines the background to the research into creativity in the primary phase within design and technology, currently being undertaken. It focuses on the model of creativity that is being used, the methodology for data collection, the way in which the pilot has been undertaken, and some analysis of the findings to date.

The Background

The introduction of outcomes-based education (OBE) in the South African curriculum, in 1998, signified the recognition of technology as one of eight core learning areas in schools of general education (Grade R to Grade 9). Since then, a revised and more streamlined version of the curriculum has been introduced, commencing with the foundation phase (Grade R to 3), in 2004.

In the Revised National Curriculum Statement (NCS), the Technology Learning area is described as aiming to develop citizens who can display the competencies and values encapsulated in the critical and developmental outcomes. These outcomes envisage learners who, inter alia, will be able to identify and solve problems and make decisions using critical and creative thinking. While the development of learners' creative thinking in problem-solving contexts is seen to be one of the important generic outcomes underpinning OBE, little is known about how learners actually use their creative thinking skills to solve problems, or how these skills may be expected to develop from a young age. In the Technology Learning Area Policy Document, the design process is described as a creative and interactive approach that is used to develop solutions to identify problems or human needs. The technological skills of investigating, design, making and evaluating are recognised as forming the core the design process and

Technology is defined as follows:

> *"The use of knowledge, skills and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration." (Department of Education, 2002:4)*

The Research Focus

It is within the context of this background information that case study research, namely to investigate the value of technology as a catalyst in developing young learners creative thinking skills, is being carried out.

Key Research Questions & Implicit Hypotheses included the following:

- What is the nature of creativity in Technology? Can certain creative thinking patterns be observed as learners engage in the technological process?

Implicit Hypothesis: Aspects of creativity can be observed during Technology.

- If so, what aspects/features of Technology can be identified as influencing and contributing to the development of creative thought?
  Implicit hypothesis: Unique features of the technological process such as investigating, designing, making and evaluating products influence and contribute to the development of creative thought.
- Can creativity be assessed in Technology? If so, what aspects of creativity will be assessed, what criteria will be used and how will this be done?
  Implicit hypothesis: Aspects of creativity can be assessed in Technology. A creativity model will be designed and developed for the purpose of identifying and tracking learners' creative thinking as they engage in the technological process.

The findings of a seven-month pilot study conducted with a small sample of Grade 2 learners, at an independent school, in 2004, have been analysed and interpreted within a conceptual framework, namely a creativity assessment model, that has been developed to explore and assess the relationship between creativity and technology. The model identifies certain variables of creativity and key features of technology considered relevant for this study. Consistent thinking patterns emerge as young learners engage in technological tasks that would appear to indicate that some relationship between creative thinking and technology does exist.

Whilst definitions of creativity reveal a host of diverse characteristics, most definitions realise its complexity and, although there is no one single definition, most creativity researchers endorse the view that creativity involves the creation of a useful and original product (Sternberg 1999:449). Using Sternberg's definition that creativity "is the ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful, adaptive concerning task constraints)" (ibid. 3), a model that attempts to analyse the relationship between young learners' creative thinking skills as they engage in technological tasks, is proposed. By its very nature, Technology would appear to strongly correlate to the notion of a creative curriculum, where children are given the opportunity to arrive at their own solutions to problems, as they develop and form ideas through sketches and models.

The Pilot Project

As this research is still in its initial stages, the model developed in the pilot study is an initial attempt at gauging the relationship between creativity and technology. As the research progresses, it is envisaged that the model will be continually reworked and refined in order to test the assumption that Technology acts as a catalyst in developing and enhancing creative thinking in young learners. The conceptual framework of this model incorporates research conducted by MacKinnon in Fishkin &.Johnston (1998) and Boden (2001).

The pilot project commenced in April and continued to December 2004. As a specialist teacher of Technology from Grades 1 to 6, at an independent school, it was decided to focus the research at Grade 2 level. Negotiating access to the learners was a simple procedure and an 87% response was received via letters to parents. At the school, learners in the Foundation Phase (Grades R – 3) are placed in different classes according to a policy of mixed ability and, as far as possible, gender balance and culture.

After Initially envisaging that the development of all Grade 2 learners would be tracked during the course of the entire school year, three sets of sample groups, were selected using the systematic sampling strategy suggested by Cohen and Manion (2002:100). Targeting a period of three months per sample group (equivalent to one school term), the research population was divided into three phases and a sample of approximately 27 learners, per phase, were selected. At the end of phase 1, it was soon apparent that a research population of 27 learners did not yield adequate in-depth data over such a short period of time. The fact that the research groups would change in phase II and again in phase III, meant that data collected would tend to be superficial, rather than in-depth. Consequently, it was recommended that the research sample be reduced and that a reduced sample be selected using the same research group from phase 1. Using the same method of systematic sampling, a representative research sample of six Grade 2 learners from the phase I research group was selected, namely three boys and three girls.

The Proposed Creativity Assessment Model

Domains

Four domains were initially envisaged for the model although only two were captured in the data analysis during the pilot. These domains are briefly as follows:

- Domain-relevant knowledge and skills which have been coded KS. Knowledge and skills refer to the technological process of designing, making and evaluating, in the model. In the South African, Revised National Curriculum Statement (RNCS) (2002:6), the technological process is stated as the backbone outcome of the Technology Learning Area and it is the only one prescribed for the Foundation Phase, i.e. Grades R -3. It was, therefore, decided to include this in the model. Categories included in this domain are conceptual, technical, constructional, aesthetic and inventive, as they would appear to best capture the essence of the technological process in the foundation phase;
- Thinking patterns which I have coded TP. The criteria in this domain may well change over time but, as a starting point, it was decided to include only four qualifiers namely, free-flowing, flexible, reflective and original. This decision was taken after browsing through several books on creativity authored by Boden (2004), Craft, et al. (2001), Cropley (2001), Gardner (1993), Sternberg (1999) and Sternberg (2002). They are also based upon my own thoughts and experience in teaching technology;
- Environmental influence which has been coded EI. This domain may be characterised by qualifiers such as supportive, flexible and freedom of choice are deemed suitable in a technological learning environment. The researcher believes these qualifiers to best support creativity in a technology classroom and, although they have not been included for analysis in the pilot, they are viewed as implicit in teaching technology;
- Learner attributes coded LA. The term learner is used as it is reflected in all South African documentation. Deciding on qualifiers for learners in this domain proved to be difficult, as there are so many to choose from. Eventually, four were selected which were deemed to reflect the type of learner engaged in technological pursuits, i.e. intrinsically motivated, task-focussed, independent thinker and collaborative worker (group projects).

Tallying of Information and Analysis of Codes

The codes referred to in the model have been used to analyse the learners' audio-taped responses in the interviews as reflected in the individual and composite case study analysis. It is envisaged that questioning skills and coding techniques would improve and I gain more practice and skill in analysing learners' responses and portfolio work, so should my coding technique become more consistently accurate.

Whilst tallying and rating of learners' technological knowledge and skills and thinking patterns are subjective and, possibly, flawed, a start has been made by trying to analyse the children's level of technological input as it relates to their creativity. Quantitative scores of individual case studies have been allocated to each of the criteria to give some indication of levels of creativity, i.e. high (H), high to moderate (HM), moderate (M) & low (L) levels of creativity are reflected in the case study analyses.

Data Collection

Audio-taped Interviews

Interviews were conducted after lessons, during free, non-teaching time initially with groups of learners in the initial phase of the pilot and, thereafter, on an individual basis with the reduced sample. Towards the end of the pilot, some interviews were conducted during class time. Generally, some projects were better researched than others, e.g. the slip-on shoes & pig's homes were carried out more consistently, whilst the chairs & kites were carried out retrospectively, where only evaluations of the final products were made.

Portfolio of Learners' Work

Portfolio of learners' work were included were discussed during

Table 1: The Model			
Categories	Code	Description of Category Coding System	Rating
Domain-relevant knowledge and skillsT	KS	**The Technological Process – design, make, evaluate**	H; HM; M; L
Conceptual	KS1	Develops, refines & re-conceptualises ideas	
Technical	KS2	Shows proficient physical skills when using materials & equipment to cut, join, fasten, glue, etc	
Constructional	KS3	Applies knowledge & skills to design & make a quality product, evaluate the outcomes & modify where necessary	
Aesthetic	KS4	Takes note of elements of colour, shape, form & texture to enhance plans & models	
Inventive	KS5	Uses resources in novel ways when seeking solutions to problems	
Thinking Patterns	TP	**Developing Ideas**	
Free-flowing	TP1	Expresses ideas easily, either verbally and/or graphically	
Flexible	TP2	See problems in different ways & explores alternative solutions	
Reflective	TP3	Rethinks, refines & replaces ideas in order to reach desired outcomes	
Original	TP4	Combines old ideas into new showing uniqueness & novelty – puts a new stamp onto an existing product.	
Envirnmental Influences	**EI**	**The Learning Environment**	
Supportiveness	EI 1	Supports and encourages individual choices	
Flexibility	EI 2	Allows for imaginative responses within task constraints	
Freedom of Choice	EI 3	Provides the opportunity to work individually or in a group; Provides a wide range of resource material	
Learner Characteristics	**LC**	**The Learner**	
Intrinsically-Motivated	LC1	Shows intrinsic motivation to tasks	
Task focussed & energetic	LC2	Pursues tasks wholeheartedly & enthusiastically showing high energy	
Independent thinker	LC3	Self-reliant & independent	
Collaborative worker	LC4	Collaborates & develops ideas with others	

the audiotaped interviews and were taken into account during the coded responses.

Data Analysis

Selected transcripts of audio-taped interviews
Code: Plain font denotes researcher's questions & responses; Italics denotes learners' responses

Case Study 1: CS1
Designing and making a pair of slippers/slip-on shoes
Making:

> *"I like those shiny things & you've got some braid there so I can see some really unusual things that you're going to use to design your slippers and make them attractive. Anything else, you'd like to tell me about what you've got there in front of you."*

> *"Yes, I'll tell you how I made them. First, I asked you for some cardboard & I cut around it. This is what I've done I've just put cotton wool & stuck it on." KS2; TP1*

I can see that those slippers are really going to be comfortable. KS4 Tell me, underneath, your slipper, your sole there, how are you going to make it non-slip? What are you going to put on there?

> *"I'm going to bring some beads from home. They're a bit pointy & you stick them on." KS5; TP2; TP4*

Case Study 2: CS2
Designing and making a home for a pig
We're going to chat about the house that you're busy making. I'm going to look at your plan & you're going to tell me why & how you changed your mind & how you're going to go about making your redesigned house. I can see two boxes here. Are you going to tell me how you're going to make them into the home of your plan?

> *"I'm gonna cut a door on one of the boxes & the other one & I'm going to join them together, at the sides, or I'm just going to tape them together." KS3; TP1; TP3*

In the other class they did that. They stuck the two boxes together & we held them together with pegs while the glue was drying. What rooms are you going to have downstairs?

"I've changed my mind because it's not working." TP3

Tell me about those sticks there.

"I was going to use these to put another roof up here, but now I'm going to use these sticks to make the roof & to hold it up." KS1; TP1; TP2; TP3

What did you plan to do with your roof?

"I'm gonna put the roof flat & put I'm gonna put the sticks on top of It." TP1

You just said to me when we came up here you said that you were going to put another level on. Are you making a double storey or just a single level?

"I'm trying to make a double storey but I need another roof because that one's curved. Cause when I make a double storey I'm gonna need three boxes. See, I'll put one on the side and another one here." KS3; KS5; TP1; TP4;

What do you plan to do for your top level of your home?

"I'm gonna make a ladder first." KS5; TP4

How're you going to do that?

"I'm going to use the sticks & cut them into little pieces onto two big pieces like this." KS2; TP1

I can see that …… those (pointing to the small sticks) are called the rungs of the ladder where you put your foot to climb up. Now, are you planning with anyone else or are you doing this on your own.

"This is my plan. The last time I worked with someone & things didn't work out. I always have to help Jack (previous partner – not real name)."

Case Study 3: CS3
Designing and Making a Kite
Evaluating the project

Looking back …

Looking at your drawing of your plan to make your kite … I know that it worked rather well. Can you just tell me about the materials you used & how you put it together.

"Well, I used a paper packet & I put some sticks through to make it stable and the two holding things I put two lines through there." KS1; KS2; KS3; KS5; TP1; TP4

And how did your kite fly on the day?

"It flew perfectly even for a while." KS2; KS3

Did it stay together? It didn't come apart?

"No, none of it came apart." KS3

Why do you think your kite was so successful, because some people's weren't as successful as yours?

"Well, I tried to make it as light as I could". KS3; TP3

And do you think that the plastic packet was..

"…The lightest thing I could find." KS3

The lightest thing you could find. I can't remember the colour of your packet, but if I look at your plan here was those holes or designs on the packet

I tried to do some designs but I did poke some holes in back so that air wouldn't get caught up so it wouldn't go like you know, so it wouldn't just catch there, but so that the air would go through. TP1; TP3; TP4

Case Study 5: CS5
Project: Designing and making a chair for a bear
I see a lovely chair here. A very unusual chair that really matches your teddy that you chose. I see that you used some unusual things to make your chair. Tell me how you joined all the things together. KS1; KS2; KS3; KS5

"I used a box to make a place for her to sit & I used cotton to make it soft". KS4

What did you make your pillow from?

"Cotton & wool." KS4

Very nice. What did you use for the armrests & the legs?

"I used toilet rolls & those little bottles for the armrest." KS5; TP1; TP4

They look like those vitamin containers. If we look at the back of her chair, I see that it is slanted slightly to fit into her back & make it comfortable. What did you use for the back? KS3; KS5; TP4

"I used the same box that I used for her to sit on."

Looks like a sticky tape box, but you covered it so beautifully with shiny paper. KS4

Table 2: The Responses

Coded responses relating to the transcribed audiotaped interviews have been indicated by placing a P in the appropriate columns. Responses were then tallied & totalled in the table according to the different projects

Coded Names	**Knowledge & Skills (KS):** Conceptual (1); Technical (2) Constructional (3); Aesthetic (4) Inventive (5)					**Thinking Patterns (TP):** Free-flowing (1) Flexible (2); Reflective (3) Original (4)				**Learner Characteristics (LC)** Intrinsically -motivated; Task-focussed & energetic; Independent thinker Collaborative worker **Learner Profile Summary**
CS1	1	2	3	4	5	1	2	3	4	
Chair		3						3		KS: High level of technological competency. Plans & products are highly aesthetic, Novel use
Slippers	3	333	333 333	333 333 3	333 333	333 3	3	333 33	333	of resources evident. TP: High level of fluency, reflection & originality.
Kite	3	333	333 3	333	3	3		3		Questions asked did not reveal problem-solving flexibility. General: Although she worked
Home	333 333	333	33	333	333 333 333	333 333 3	3	333 33	333 333 3	with a peer in last project, she tended to direct the planning & making process. Focuses fairly strongly on aesthetics when planning & making. Tally count: KS: 59; TP: 36 (Total: 95)
TOTAL	8	10	12	13	16	12	2	12	10	Rating: High creativity
CS2	1	2	3	4	5	1	2	3	4	
Chair	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	KS: Moderate technological competency evident. Low technical & inventive
Slippers	333 3		33	3	333 3	3		333 3	3	competencies. TP: Much prompting needed to elicit ideas in most projects.
Kite	3	3	3	3		333 3		333 333		Answers ranged from fluent to monosyllabic responses. Reflective skills show increasing
Home	3	3	333		33	333 33	3	333 33	33	ability to refine & modify ideas. Tally count: KS: 22 ; TP 25 (Total: 47)
TOTAL	6	2	6	2	6	9	1	10	3	Rating: Low creativity

Table 2 *continued:* **The Responses**

Coded responses relating to the transcribed audiotaped interviews have been indicated by placing a P in the appropriate columns. Responses were then tallied & totalled in the table according to the different projects

Coded Names	Knowledge & Skills (KS): Conceptual (1); Technical (2) Constructional (3); Aesthetic (4) Inventive (5)					Thinking Patterns (TP): Free-flowing (1) Flexible (2); Reflective (3) Original (4)				Learner Characteristics (LC) Intrinsically -motivated; Task-focussed & energetic; Independent thinker Collaborative worker **Learner Profile Summary**
CS3	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	
Chair	3	3	33	3	33	3			33	KS: Refines & re-conceptualises ideas during the technological process. Some focus on
Slippers	333 33	333 33	333 33	33	3	333 333 3	33	333 3	333	aesthetics. Outcomes are inventive but this has not come through strongly in these
Kite	3	333	333 3		3	3		3	3	ratings. TP: Expresses thoughts fluently & reflects well.
Home	333 333 3	3	3		333	333 33	333 33	333 333 333	333	Is an original thinker. Is an original thinker. Tally Count:: KS: 46; TP: 44 (Total: 90)
TOTAL	**14**	**10**	**12**	**3**	**7**	**14**	**7**	**14**	**9**	Rating: High creativity
CS4	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	
Chair	3	3	333	333 3	33	3		3	3	KS: Refines ideas while working through the process Is inventive.
Slippers	333 3	3	333	33	3	33	3	333	3	TP: Thinks fluently, flexibly & reflectively. Outcomes are very original.
Kite	3	3	3		3	33	333	333	3	Tally count: KS: 45; TP: 52 (Total: 97) Rating: High creativity
Home	333 333 3	33	33	3	333 333	333 333 333 3	333 333	333 333 333 3	333 333 3	
TOTAL	**13**	**5**	**10**	**7**	**10**	**15**	**10**	**17**	**10**	

Table 2 *continued:* **The Responses**

Coded responses relating to the transcribed audiotaped interviews have been indicated by placing a P in the appropriate columns. Responses were then tallied & totalled in the table according to the different projects

Coded Names	Knowledge & Skills (KS): Conceptual (1); Technical (2) Constructional (3); Aesthetic (4) Inventive (5)					Thinking Patterns (TP): Free-flowing (1) Flexible (2); Reflective (3) Original (4)				Learner Characteristics (LC) Intrinsically -motivated; Task-focussed & energetic; Independent thinker Collaborative worker **Learner Profile Summary**
CS5	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	
Chair	3	3	33	333	333	3			3	KS: Re-conceptualises & refines ideas while working through the process. Highly inventive
Slippers	333	33	333	333 33	333 333 3	333 333	33	333 3	333 33	TP: Confident about what she is doing. Her reflective skills are not effectively captured in her
Kite	3	33	33	3	3	3		3	3	responses here. Outcomes always reflect original thinking. Tally count: KS: 48; TP: 27
Home	33	3	33	33	333 3	3		3	333 3	(Total: 75) Rating: High to moderate creativity
TOTAL	7	6	9	11	15	9	2	6	11	
CS6	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	
Chair	3	33	3	3	3	3			3	KS: Responses seem to indicate a high level of inventiveness. Conceptual technical,
Slippers	33	3	3	333	333 3	333 333 3	33	333 33	333 3	constructional & aesthetic skills are more or less on a par and appear to be moderate to low.
Kite	3	3	33	3	33	33		33	33	TP: Thinking patterns seem to indicate a high level of fluency, reflection and originality.
Home	333	33	33		333 333 3	333		333 333	333 333 3	Whilst he did seem to explore alternative solutions to problems when engaged in tasks, this is not reflected here. Tally count: KS: 38; TP: 42 (Total: 80)
TOTAL	7	6	6	5	14	13	2	13	14	Rating: High creativity

Analysis of the Findings

Transcribed, audiotaped interviews, although time-consuming, proved most useful for reflecting precisely on how learners think during technological tasks. Individual interviews during and after technological activities, resulted in the collection of far more in-depth information when compared with the data collected during group interviews held during the initial and first phase of the pilot. The coding system used to analyse and then tally responses would appear to have helped captured and tracked the responses that emerged within and across the six different case studies

The emergence of consistent ideas in the individual case study analyses seem to indicate that a relationship does exist between young learners' technological knowledge and skills and thinking patterns during technological tasks, irrespective of the project theme.

The implicit hypotheses namely that aspects of creativity can be observed in technology and that the unique features of the technological process do to some extent influence and contribute to the development of creative using a creativity assessment model would appear to support further research in this field.

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Technological Development and Development of Technology Education

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On a national and international level, technology education is considered to be part of general education. This paper highlights causes and effects, and presents the concepts that are available today for teaching technical subjects. Also discussed is a comprehensive, open approach which covers the essential invariant characteristics of technology education.

Technological change has become an increasingly dynamic and complex process. As a result, a fresh look has to be taken at technology education, which is one of the major aspects of this paper. Only if technology education adequately considers the invariants of technology as well as up-to-date standards of science and technology, can students be enabled to solve technical problems that are of immediate relevance for life.

Technological development

Developments in technology cannot be illustrated without taking a closer look at what is understood by technology. A distinction can be made into the following aspects:

- Technical systems (artefacts and processes)
- Technical action for the generation, use, and dissolution of technical systems
- Knowledge/awareness of the origins, use, and dissolution of technical systems.

Technology and its development are directed at satisfying needs of individuals and society. This implies that humans, with their individual needs and their needs as society, are the origin as well as the aim of technological development.

The very first beginnings of technology are closely related to the evolution of mankind. Man has taken technology from the first primitive stone tools through all its stages to to-day's high level of sophistication. In view of the complexity of the issue, the question as to what has changed and what has remained the same deserves a closer analysis.

Changes in needs

Let us take a first look at the needs that have to be satisfied. Today, as in the past, technology is expected to satisfy the basic needs of humans, which include lodging, clothing, food, health, etc. However, new and different needs were created as human societies developed, and these needs may by far go beyond the satisfaction of basic needs.

Changes in technical action

The basic principles of technical action (becoming aware of needs; defining tasks; developing ideas; manufacturing, using, and disposing of products), which aims at satisfying needs, has not changed. Technical action involves such activities as innovating, creating, designing/calculating, optimising, producing, analysing, using, experimenting, recycling (Liao 1994, 2002).

Now as before, all technical activities are always complete activities that have to cover the stages informing, planning, implementing and analysing.

Technical action is the tool by means of which humans have successively appropriated nature in the form of technical artefacts. In this way, they have always influenced and changed both nature and the society they lived in, and this has in turn acted back on humankind itself.

What has changed is the intensity of the effects of technical action. Today, humankind is in the position to effect not only long-term changes, but also changes that may reach menacing proportions. The tools humans use for their actions have changed, too, and the division of labour has reduced the extent to which individuals participate in these actions to selective subactions, as a consequence of which the individuals involved have to be brought together within networks.

Changes in technical processes

When subjecting technical processes to a closer analysis, one will find that the basic structure has again remained unchanged. Operands are transformed in sub-processes/operations from state A to state B through the action of operators. This is true irrespective of whether matter, energy and/or information is transformed. The operators may be machines and humans performing functions or tasks that have been defined for the process in question.

What has changed is the degree of involvement and the role humans play in technical pro-cesses. Mechanisation and automation has allowed humans to assign an ever increasing number of tasks to machines, leaving supervising and monitoring functions to themselves. Machines have made it possible to network technical processes that used to be separated and integrate them to highly complex units (e.g. data transfer in the world-wide web). Although closely related to all things that are technical, humans have at the same time moved away from the technical processes, sub-processes and operations as such.

The physical, chemical or biological principles of action determining technical processes have not changed. But today human beings have the ability to avail themselves of an increasing number of natural laws for closely defined purposes, as, for instance, biosensors or laser technology.

Changes in technical artefacts

The pace at which technical artefacts are changing is evident for everybody. This change affects the shape of artefacts, the size (miniaturization: nanotechnology), and the efficiency. For instance, cars and computers that are in common use today differ in a number of ways from earlier generations, while the basic functions are still the same. A fork or a knife have not seen any change in their basic functions, nor has the basic function of a car, which is to transport an object from A to B, experienced any change. Only new functions have been added to the list.

Changes that have taken place concern the degree of cross linking and complexity of technical artefacts. An example that can be mentioned in this context is the intelligent house. The way in which technical artefacts are produced have undergone changes, too. The use of heavy-duty materials, the quality of the products, and the automation of the manufacturing process, which allows large quantities to be produced at a constant quality, are indica-tors of the high level of sophistication.

Changes in knowledge

The half-life of technical knowledge is decreasing in the same manner as this is experienced for other disciplines. Technical know-how is exploding as intervals between inventions, discoveries and developments are becoming shorter and shorter. During the early stages of technical development, knowledge was normally generated from experience and was handed down to the next generation as empirical knowledge. This was also true for the handicraft/practical phases of the Middle Ages.

The scientification of technical methods is a relatively recent phenomenon, which employs mathematics as well as the natural sciences as methods to generate scientific insights. The process of scientification eventually produced such specific disciplines as information and communication technology, as well as biotechnology and genetic engineering, environmental technology, energy technology, material technology, aviation and space technology, traffic engineering, micro technology, laser and plasma technology, medical engineering and building engineering, which may affect the reality of life of each individual. It is worth noting at this point that there is an increasingly higher level of interconnection, both between the different technical sciences, and between the technical sciences and the natural sciences and mathematics (e.g. mechatronics, biotechnology). Information technology, in addition, plays an important role as a basic technology for all technical sciences.

But also the way of how knowledge (or rather information) is passed on has undergone substantial change, as oral tradition, and later hand-written and printed documentation, was replaced until information technology became the major instrument for passing on knowledge. This technology is now providing almost global access to information, irrespective of place and time.

Changes in responsibility

In the course of its development, technology has allowed both people and peoples to move closer together and to overcome dimensions and distances. At the same time, mankind is now in a position to put its livelihood at risk. Even without waging war, which would certainly be tantamount to absolute destruction, we can do a lot of damage to our basis for living, merely as a result of technical action – if it takes place without being aware of, or considering, the principles of interaction.

It follows from the above that for today's humankind it is important to understand the implications of technology. This will allow us to develop, and make use of, new technical systems in a way that reduces consequences and risks to a manageable level. Only those who understand how technology affects all walks of life, and that, by using technology, human beings act back on themselves, can translate knowledge into responsible action.

Technology education

Significance of technology education

According to Schlaffke, general education should be seen as a foundation which "is ready to support a complex building of education – with an increasing number of storeys and corridors". General education should provide global knowledge, and the ability to think along structural, procedural, or systematic lines, but also standards of value, which are all combined to form one complete concept (Schlaffke 1997).

Education is more than knowledge, which, on the face of it, can be utilized as a key to the job market and a means of social balance. Education has to prepare for a "life in freedom and self-determination". It has to enable individuals to cope in an "open and highly complex world offering new kinds of freedom", without allowing themselves to be drowned in a "maze of facts and events". Education must not remain limited to imparting knowledge and functional abilities. To allow human beings to develop their personality, education also means imparting values and social competences. On the other hand, school education must not remain separate from the realities of life. Schools have to arouse and encourage interest and inclination, no matter whether this means developing practical or theoretical talents. They have to counteract premature specialisation, offer a wide range of subjects, and thus impart a broad basic knowledge, without heeding later professional carriers (Herzog 1997).

If we endorse the conception according to which school education should enable individuals to cope in a highly complex world and to understand the significance of technology for the reality of life of individuals, as well as its significance as a cultural heritage, technology education undoubtedly has to be seen as being part of general education.

Education comprises three basic components. These are the process of imparting knowledge as an informational component, the process of learning to learn as a didactical component, and the process of arousing interest as a motivational component. Against the background of a rapidly changing technical world, the question is what technical knowledge should be imparted, what share should the informational component of technology education have. "As technical systems are becoming more complex [...] and as we are abandoning the utopian idea of understanding technology, the didactical and motivational components of technology education are gaining significance. Today, education is, therefore, a-bove all the ability of learning how to learn. It is not the product-, object-, or formula-based learning which gives access to understanding, but the process and phenomena-related learning, and the ability to apply the acquired knowledge and translate it to other fields" (Pfenning 2002).

If "understanding technology" was referred to as utopian above, this primarily means the impossibility to understand technology as a complex phenomenon with all its facets. Technology education should rather aim at presenting technology within a context by relating to examples, and thus illustrate underlying structures and functions. The insights thus gained can then be raised to a meta level which offers the possibility of transferring acquired knowledge. Ideal tools for his purpose are system theoretical models (Hubka 1973, Wolff-gramm 1994, Ropohl 1999, Luhmann 2002).

The intention of technology education is to develop a competence to act in every student, irrespective of any later professional carriers or any personal inclinations or preferences. This competence is seen as the disposition of the individual to successfully solve problems in a given technical situation.

Technology education should aim at enabling students to:

- Be part of a process in which a world undergoing technical change has to be given shape
- Be capable of responsible technical action, which gives due regard to the interrelationship between humans, nature, technology and society
- Cope with technical/practical requirements encountered in our daily lives and on the job
- Understand the principles of technical systems
- Be able to use their basic technical understanding to decide in favour of a technical profession.

Development of technology education

Developments that have taken place in technological fields have also had their effects on technology education, but other factors have also plaid their role. These include the economic and political situation, the pedagogical mainstreams, and the significance that is at-tached to education. Some of the main concepts of technology education, which may still be relevance today, are outlined below (cf. Graube, Theuerkauf 2002).

Manual skills

Manual skills with their practical orientation started to be taught as a school subject in Finland, Sweden and Denmark at the end of the 19th and beginning of the 20th century. But the Vienna World Fair in 1873 and the Philadelphia Centennial Exhibition in 1876 made it quite clear that the quality standard of industrially produced consumer durables was poor, which was attributed to inadequate practical handicraft skills in handling machinery and tools.

Manual skills as a subject not only aimed at improving the skill as such, but also at supplementing the purely theoretical subjects and thus striking a balance between physical work and mental activities as one means of encouraging the full development of the student, which was one of the basic pedagogical requirements. The skills taught concentrated on traditional manufacturing methods and the systematic development of the ability to handle such materials as paper, cardboard, timber, and metal. The subject was widely introduced in many countries, including the US, Russia, Romania, France, England, Hungary, Austria, and Belgium.

Polytechnics

The polytechnical approach dates back to the first polytechnical schools in Paris in 1794, which was the time of industrial schools. Marx started from the ideas and principles of this école polytechnique to develop a concept of education, in which brainwork, physical work, and a polytechnical education combined to form one unit. With this concept, the polytechnical part covered the general scientific principles of all production processes and also the practical use and handling of the elementary instruments needed to perform the production process. The concept implied a fundamental expansion of earlier practical handicraft ap-proaches to arrive at a technical and economic education, which combines theoretical as well as practical elements of work.

This educational concept could not be implemented until after the first socialist countries came into being, i.e. after the fundamental changes had taken place in the 20th century in production and ownership structures. Politically, the polytechnical approach aimed at the education of socialist personalities. What its proponents had in mind was a technical and economic education that was to encourage people to take their share and responsibility in shaping society.

The curricular programme of polytechnical education concentrated on production processes and engineering sciences. A special feature of these schools was that, starting with the primary to the school leaving levels, the subjects were based on each other, that a shift took place from school as a place of learning to a more practical environment (workshops, polytechnical cabinets, industrial workshops, production departments, development depart-ments). This was accompanied by a change from supervised practical activities to practical scientific work.

Despite its distinct political orientation, the significance of polytechnical education has to be seen in the close links between education and the technical/work environment, in the uniform technical education it offered, in the fact that it provided a defined transition to vocational training or university education, as well as in a consistently developed and coordinated concept and teaching materials.

Work orientation

Work orientation means to focus on the actual work environment and the interrelationship between humans, work, technology and economy. Needs are assumed to be a starting point, and work is seen as a tool that can be used to satisfy these needs. From this follows that technology is always viewed in its relationship to work and its influence on humans. The aim of this approach is to convey insights into work processes, to develop a positive attitude to work/technology, and to help prepare for an active professional life (Oberliesen 2002).

In curricular respects, the approach starts from the model of the business process and integrates the fields work/profession, home economics, technology and economy. The work orientation can be seen as a more advanced level of manual skills teaching, with its deve-lopment from a handicraft to an industrial approach.

In countries, which do not know the German dual vocational training model, e.g. China and the United States, this concept is of special significance. This approach is also where the German "Arbeitslehre" would have to be located.

General technology – systems theory

System theoretical considerations relate to thinking in terms of systems, which is typical of humans and takes us back to the ancient world. This way of thinking means to comprehend things within global contexts. More specifically it means that all technical systems are re-garded from the point of view of material, energy and information and their modifications. Originally, this approach was a fairly strict technical approach relating to the processes and artefacts involved. It has now been expanded to include socio-technical aspects.

The significance of this approach, i.e. thinking in terms of systems, has to be seen in the fact that it helps to think in terms of models and thus has a propaedeutical scientific element. It aims at conveying engineering subjects and methods and is to prepare for engineering courses at university. In the US, and also at the secondary school level (Sekundarstufe II) in the federal states of Brandenburg and North Rhine-Westphalia, this approach has, for instance, been integrated into the curriculum. [1]

Science and technology

This approach is rooted in the natural sciences and the engineering sciences, as well as their specific methods. Solutions may be sought in either scientific or technical options. The underlying aim is to develop cognitive skills (thinking in terms of systems), to develop research and planning skills (planning of experiments and processes), and to develop practical skills (performing measurements, producing electric circuits). This approach is valid for elementary schools, as well as for junior high schools or senior high schools. In teaching the subject, scientific and technical elements are linked. This approach is actually used as part of the subject Science and Technology in the United States and in Israel. But in Germany, too, similar methods are used for illustrating phenomena in the natural sciences, with concrete technical applications.

Design and technology

When technology education focuses on design as part of its teachings, this is because needs and desires are at the bottom of any development, and for developments to take place, the-re have to be inventions. For this reason, this approach is directed at developing innovative skills and creativity, or in other words, at turning students into creative inventors and problem solvers (Kimbell 2002).

The curricular programme concentrates on inventing, producing and evaluating products. Central elements are the processes of invention and design, while production is of lesser significance. This approach is implemented in England as well as Australia as part of the subject Design and Technology.

Implementing Technology Education in schools

The concepts for technology education as outlined above incorporate different kinds of technical action, which may also vary as to its emphasis. Concepts for technology education have changed along with developments that have taken place in the technical sector and along with what were seen to be educational requirements.

When considering the complexity of today's technical systems, technical action may serve as a key that gives access to technology with its basic structures and functions, and the aspects linking it to humans, nature and society. This relationship for technical action is also found in international concepts, where reference may be made to such fields as building and accommodation, work and production, supply and disposal, information and communication, food and health, clothing, playing and learning, which relate to the students' immediate life experience.

In dealing with the above fields of action, the attention should be directed at such guiding principles as the preservation of the environment, careful use of resources, and protection of the human dignity and the cultural heritage (Klafki 1995). Depending on the cultural, political or economic situation, in which action has to be taken, different fields of action may be attributed special importance.

As a general conclusion, technology education can be said to be integrated into school curricula in the following way:

- Primary level: phenomenon-based work
- Secondary level I: theoretical and practical work
- Secondary level II: propaedeutical scientific work

For technology teaching at what are seen to be open schools, external partners are increa-singly integrated into the programme. These may be partners in industry, handicraft busi-nesses, the service industry, or (educational) institutions, who may have the function of initiating tasks or offering room for action, or they may provide experts or equipment, as well as the necessary professional orientation. At the first level of secondary school education, suitable partners would, for instance, be the production sector of small- or medium-sized businesses or handicraft businesses, while for the advanced secondary school level this could be planning and research in industry or at universities. Positive experience with this kind of cooperation has already been made (MINT, TheoPrax, Step-In, etc.).

Conclusion

Interest in technical matters can be aroused when the subject is introduced in a playful manner at an early stage, and this interest can be consolidated when technology forms part of the curriculum from the primary level to the school leaving age. Technical tasks that combine theory and practice can, in addition, be motivating and have a reinforcing function, because the result of the learning process is a real and concrete result.
Developments in the technological field require everybody to be permanently involved in the subject, so that the function of technology education is to prepare for lifelong learning.

Notes

[1] Technical aspects are linked with mathematical and scientific elements, as well as elements of a mathematical-scientific-technical nature.

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On Strategy to Activate Children's Creativity with the Examination of Inventor Process of Invention

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Introduction

Citizens' creativity is deemed to be the crux of elevating a nation's competitiveness. The development of a nation would be stagnated and will eventually be eliminated without creativity. Take the recent education reform policy of Australia for instance. Among the seven "key competency" of cultivating the students, the capability of problem solving and employing creativity have been included. Likewise, the developmental program for the Knowledge Economy has also clearly proposed elevating competitiveness through the cultivation of people's creativity (Council for Economic Planning and Development, 2000). Indeed, the nurturing of creativity should begin with children from a young age. The Grade 1-9 Curriculum Guidelines issued by the Ministry of Education in 2000 has distinctly stated the aspiration of cultivating students' ability to explore and research actively, which echoed with the Australian education policy. Facing the era of multiple development of knowledge economy, the elevation of children's creativity in the future has currently become the new drift of educational policy internationally. The cultivation of the capability of creative thinking and problem solving within children is not only crucial to the nurturing of their life-long learning ability but also influential to the potentiality of the nation's collective creativity and innovation.

The development of children's creativity is inseparable with that of children's psychology. While the performance of creative activity has begun from infancy, it continues to activate on various behaviors (Jen, 2001). However, the discipline-oriented teaching context, knowledge-based teaching method, unit-correct answer evaluation and teacher as the authority lecturing are still prevalent among current school education. These methods over emphasized on cultivating children's linear thinking ability while being oblivious to innovating multiple thinking ability such as horizontal, expansion thinking, and special thinking. Creativity among the children of elementary stage, to be specific, is inspired from learning activities. They all generate creativity whether teaching is from the class or from group activity. Through activities, children's potential is inspired, their sensory capability is trained and coordinated, and their adaptability to strange environment is developed. Equipped with these, children's curiosity towards the surroundings and the craving for learning will be geared.

Children's discovery of problem and their approaches to problem solving in it, is an innovated creativity. The creative thinking generated at the moment would surely lead to newer and more creative ideas with the incorporation of creative thinking, and is bound to turn into feasible or valuable scheme (Huang, 1993).

Creativity cannot be just a dot, or a sparkle. It has to be the extension and implementation of thinking, through which discovery and research thinking takes place, and finally leads to solution and invention. Invention is then the embodiment of creative scheme, the presentation of human creative behavior. Displaying on the level of science and technology is the employment of different approaches, through considering, testing and eventually innovate, improve or change the face of fact (Chen, 1991). The writer has presented a hypothesis that "the mindset operation process is similar in terms of innovation of any discipline or knowledge domain. The distinction of innovated output originated from the disparity of mindset operation elements" (Wu, 2000). Csiksetmihalyi holds that to be creative, one has to internalize the knowledge or information so as to incorporate creativity into a feasible system (Tu, 1999). Thus, as elevating children's creativity has become the goal for elementary education, it is an urgent issue as to how to transform the analysis of the mindset operation process of inventors into a strategy/ies to cultivate creativity.

Creativity, the connotation of invention, and strategy

Creativity exists in every human (Wiles, 1985; In-hau, Chen, 1982). It is an inborn ability with human beings, and is the drive for the progress of society and individual as well. Torrance (1966) specifies that creativity should include fluency, originality, flexibility and elaboration. He then defines creativity as "a string of mindset process". It includes one's perception of the problem, information gap, the missing elements and incoherence. With these, we can detect the predicament, search for answers, and raise relevant conjecture and hypothesis. Later comes the work to confirm, reconfirm or edit the hypothesis. Finally, he can summit the report base on his findings and then contribute the result tot others".

Among the outputs of creativity, invention is one, which can most manifest its value. Invention is a form of man's thinking activity. It is a new technique that solves the problems within some domain by making use of the law from nature science (Liang & Shiao, 1992). Invention, to be specific, is the breakthrough of technical unit or recombination of a fixed technical unit, which has fulfilled the demands of creativity, solved the bottleneck of technical issues, or carried commercial benefits to a certain goal (Wu, 1989).

There exist specific thinking patterns within inventors who are extremely creative (Guilford, 1986). It is thus evident that abstracting the inventors' personal traits and invention skills based on their studies into teachable materials should be the main ground which inspires creative teaching materials and methodology. After all, successful cases can be shortcut to lead the puzzled through the clouds (Huang, 1997) the invention process and approaches of the inventors can work as modeling example, and inspires children's creativity. The research findings of the inventors' invention process and approaches can work as the foundation for editing teaching materials for cultivating creativity.

There are ways to enhance creativity. From the perspective of bettering psychological mechanism, function attachment and building creative cognitive structure. These two often work as a simultaneous mindset process or one thing of 2 sides. Creative behaviors or products can be made possible with the guidance of creative techniques and philosophical ideas on one side and realizing the ideas on the other (Wu, 2004).

During the process of creative invention, invention technique is the strategy or tool, which was applied on a certain moment. It is the magic wand to extricate oneself from the bottleneck or manifest creativity. Quite a few literatures have findings on inspiring creative thinking skills and strategies. Here specifies the popular skills as follows.

1 Deficiency enumeration

Deficiency is a matter of fact in everyday objects such as incontinent, unattractive, inefficient or unsafe. As long as the deficiency during the producing process can be identified, it can be bettered, edited targeting the frailty (Chen, 1985; Ji, 1985).

2 Expectation enumeration

It is an approach to hold aggressive illusion towards present product in the hope that it can carry more merits or function regardless of its feasibility. As long as the expectations are listed, even though it can not be made possible today, it can be realized in the future with the progress of scientific technology or the expansion of personal technical perspective (Chen, 1984; Ji, 1985; Chen, 1985).

3 Creative problem solving (C.P.S.)

C.P.S., raised by American scholar Parnes in 1967, is a creative problem solving approach, which employs systematic thinking approach to solve the problem. This approach emphasize that the problem solver should consider as many and as versatile solutions as possible before he chooses or implements solving scheme (Isaksen etc, 1994). The strategy includes 6 steps, which expansion thinking and focusing thinking (1) making ways through the mass; (2) data searching; (3) problem finding; (4) searching for ideas; (5) discovering the solution; (6) searching for reception.

4 Brainstorming

It is started by American scholar Osborn in 1938. It purports that one can conduct creative thinking, impel his mentality to come up with ways to solve a certain problem, which can be conducted through collective or individual thinking (Kuo, 1989) brainstorming can be divided into 2 principles: (1) delay judgment ; (2) search for quality among quantity; and 4 rules: (1) forbiddance of criticism; (2) welcoming free operation and daydreaming; (3) the more ideas, the better; (4) searching for combination of ideas and improvement (Osborn, 1956; Stein, 1974; Shau, 1979).

Process of the inventors' mindset operation and invention

Invention is an incessant and complex process. The style of individual mindset operation is manifested through different stages of process. In other words, invention is the gradual shaping process from abstract thinking. The subjects in this study were selected from an awarded list of creativity, 4 from the academic domain and 5 from the industrial field.

The study is firstly conducted through semi-constructive in-depth interviews, during which data of the invention process of the inventors were collected. Later, interview data, which includes personal data, patent application, interview transcript, was analyzed through qualitative analysis. Then analytic induction is used to conduct the collective analysis and data categorization so as to short out links and meanings between data. Finally, grounded theory is used to shape up ideas according to the analyzed data so that mindset operation process, including creative problem solving, information processing can be located (Howley & Pendarvis, 1986).

1 Creativity: This includes finding out ways about invention motives, thinking habits, invention ideas through interview topic.
2 Problem solving: It includes technical breakthrough, origin of illumination, time spent on invention.
3 Information processing: This generalizes the ideas which shape up mindset operation as the strategy to inspire creativity.

The process of inventors' creativity according to the findings, can be summed up into 5 stages:

1 Problem finding: The key to induce an inventor to keep on creating lies on his being able to find out places that can be improved; with that comes the following rumination, design and confirmation and implementation.
2 Searching for solution: To solve the problem, an inventor's mindset operation patterns during the thinking period is divided into following stages: (1) searching for solution in full scale: treating the problem from different angles for versatile solution;(2) weighing the pros & cons between solutions: analyzing the merit and shortage for the best solution; (3)

aiming at the shortage for the solution for improvement or alternative and edit the idea that is less perfect. Concluding from this, inventor's problem solving thinking process is a series of zooming in process, i.e., from expansion thinking to focusing thinking.

3 Actual design work: It takes action to realize abstract thinking. During the process of embodiment, the inventor would conduct his design work with the consideration of fulfilling the systematic and logic demands.

4 Confirmation: The feasibility of an idea needs to be verified through experiment so that elements of viability, thoroughness and if it can be achieved the goal can be tested. Thus, when the ideas are less than perfect, or cannot solve the problem, the inventor has to go back to the thinking stage and thus forms an active cycle. Therefore, ideas can be more completed through the experiment stage.

5 Invention finished: After the passing of the confirmation stage, product can almost be called as an invention. Yet, to make the invention more appealing, minor edification such as precision, its look can be done to make it more exquisite.

Summing up from the above, invention, through a manifestation of personal character, takes similar thinking processes, applying the same or close strategy. Thus, transforming the analysis on an inventor's invention process and mindset operation into a strategy to inspire children's creativity should be contributive to creative education.

Transformation and application of teaching strategy

1 Modeling and paradigm building-introduction of inventors

Bandura's social learning theory suggests that human's learning is acquired by learning and imitating others' behavior. Thus, it is important to build a good model and paradigm to supportthe development of children learning motives and continue their learning process.

2 Introduction of the model inventor's invention-invention is the proficiency with a touch of creativity

This is to specify to the children that invention is created on the basis of professional knowledge. It would impel children to put more efforts on learning professional knowledge. In addition, children would understand that the invented products by the inventors have close relevance with their living surroundings and the professional domain, and thus to enhance children's willingness to exercise their thinking and their ability to solve problems.

3 Introduction and application of creative invention strategy

This is to analyze inventors' invention process and their mindset operation patterns. To solve the problems, the thinking operation patterns the inventors applied during the thinking period are divided into the following stages: (1) searching for solution in full scale; (2) analyzing the pros and cons among solutions;(3) finding better solution or alternatives aiming at the shortage of solution. Concluding from the above, we can see the necessity of training children to transform their expansion thinking to focusing thinking.

With this understanding, when applied to the teaching strategy elicited from inventors' mindset operation and relevant creative strategy to inspire children to engage in creative thinking, it includes: (1) brainstorming: using group collective thinking patterns to expand children's angles to treat an issue and to exercise thinking chain reaction; (2) expectation enumeration: encouraging children to analyze the pros and cons of an issue so that many merits can be reserved or collected while shortage can be eliminated or edited; (3) deficiency enumeration: listing the deficiencies of a problem, finding out schemes to edit or improve; (4) discussion: eliciting the best solution through group sharing and communication; (5) creative problem solving: trialling children's solution before choosing or implementing the solution.

In addition, analyzing techniques how the inventor gave rise to new creative ideas and thinking, such as (1) function transferring; (2) function substitution; (3) combination of objects; (4) deleting and editing of objects. Integrating the above thinking techniques in the training activities to inspire children's creativity, children would learn to utilize their thinking techniques to expand their mentality so that problem solving and creative ideas can be made possible.

4 Closure

In short, the advantages of transforming the analysis of inventor's invention process into teaching strategies to inspire children's creativity are (1) elevating children's willingness to learn and imitate from the model and paradigm; (2) increasing children's ability in application and transferring through learning; (3) inspiring and maintaining children's learning interests and motives from versatile teaching activity designs; (4) expanding children's horizon and thinking scope; (5) training children's logic in handling situation or problem solving; (6) enhancing children's ability to raise criticism and evaluation; (7) improving children's ability in communication and self presentation.

Conclusion

Creativity is not an inborn ability but an ability that can be cultivated. Confronted with the ever-changing information and high-tech era, it is only through the utilization of thinking techniques and creative techniques that children's ability to think creatively and become problem solvers can be cultivated. In addition, children's creative ideas can be stimulated so that interests towards "invention" and "creation" will be aroused. Cultivating children into individuals with creative characters, and communicators are the preconditions to make Taiwan become an "island of green technology".

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Technology Education: Pain or Pleasure?

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Abstract

S. Africa introduced the subject Technology education into its curriculum in 1998. As with any change to the curriculum, there were many issues that arose about the philosophy for its inclusion, how it would be implement, how teachers would come to an understanding of the subject and how schools would be appropriately resources. Looking back, in retrospect we can ask ourselves just how 'painfully or painlessly' the introduction of a new curriculum was implemented.

Introduction

Technology has made an unsteady and rather painful entrance into the South African curriculum. Introduced into schools in 1998 alongside the sweeping reforms of Curriculum 2005, it suffered neglect by most of the provincial departments during 1996 - 1998 period when preparation and training of teachers was supposed to have taken place. In spite of the official neglect, the learning area made passionate converts of educators from both private and public institutions and from NGO bodies and universities, who saw the learning area as an innovation 'whose time had come' and there was a determination to see it succeed.

When the Chisholm review of Curriculum 2005 recommended that technology be scrapped as a compulsory learning area in the GET Band, the storm of protest that erupted showed policy makers would not give up the struggle without a fight.One needs to remember that it was not just internal issues in South Africa that called for educational reform. Many outside factors also played a role. Firstly there was the emergence of a global economy. With this economy came great competition and a need to train and educate people just as skilled and informed as any competitors in order to survive. For the same reason, education had to remain in tune with global trend and standards. Secondly, there has been a change in the organization of work. The organizational hierarchy has flattened, management is no longer a top down approach and unskilled production workers are no longer needed. For this reason, skilled, knowledgeable workers who are able to solve problems, work in teams and continue to learn, are now required from the schools for the work place. The development of these skills is very much a focus in Technology Education.

The biggest influence on the need for technology education is technological inventions. Countries failing to react quickly to technological developments get left behind: Consequently the standard of living of a nation and the political future of government are easily threatened. Modern economies have their roots deeply embedded in science and technology. Thus, these subjects should receive greater emphasis in the provision of education.

Accompanying the introduction of the new learning area are thorny issues. Many educators developed a fear for the 'new, unknown learning area'. As with most people, few see the opportunity offered by a new subject – rather, fear and uncertainty take the place of the challenge and one almost wishes that this fear of the unknown will bring knowledge in the form of another skilled/trained educator to start, and introduce the new learning area. This fear was highlighted during my visits to many schools during the student practice teaching period. So often educators showed willingness and were keen to get involved in the implementation of Technology Education, but had no understanding of what the expectations are. A questionnaire conducted in twenty Primary Schools aimed at grades 4, 5 and 6, was used to determine what the main areas of concern were amongst the educators and to try and assist them with possible solutions.

The Learner outcomes

The learner outcomes as prescribed in the NRC are briefly as follows:

Learner outcome 1: Technological Processes and skills.
This learner outcome deals mainly with the design process. During Technological activities, the learner engages in investigating, designing, making, evaluating and communicating solutions.

Learner outcome 2: Technological Knowledge and Understanding
The learner will be able to understand and apply relevant technological knowledge. This learner outcome includes the three core content areas, namely: Structures, Processing, systems and control. Communication is the 'golden thread' that runs throughout the curriculum.

Learner outcome 3: Technology, Society and the Environment
The learner must demonstrate an understanding of the interrelationship between science, technology, society and the environment. Learner will be made aware of indigenous technology, impacts of technology and biases created by technology.

Data collection methodology

The questionnaire was devised as follows:

- Section 1 – The core aim was to determine whether the school and the educators had seen and studied the New Revised Curriculum (NRC) and whether or not they understood what was expected of them.
- Section 2 – The focus here was on whether or not definite lesson/teaching time was allocated on the timetable and investigated the availability of facilities and equipment and looked at the learner /educator ratio.

- Section 3 – The focus was on whether or not the educator understood and implemented the three learner outcomes.
- Section 4 – The focus was on which learner outcome posed a problem.

An overview of the findings

The findings showed the following:

- Section 1: (Curriculum document)
  70% of the respondents indicated that they had seen the document but only 40% indicated that they had read and understood the document. Most educators who had read the document indicated that they understood the document but highlighted the areas that they found to be difficult.
  Those educators (30%) who had not read the document felt that they could not find the time to do so.
- Section 2: (Allocated lesson time)
  64% of the interviewed educators indicated that they had allocated lesson time for teaching Technology and that this took place in practice. Others commented that some of their lessons are shared with other learning areas.
  All educators commented on the lack of funding, limited space and minimal resources.
- Section 3: (Learner outcomes)
  60% responded positively and indicated strongly that they understood the outcomes as indicated in the NRC.
- Section 4: (Learner outcomes which posed a problem)
  All respondents indicated that learner outcome three was difficult to understand and difficult to implement.
  Although Technology has been implemented the implementation thereof has not always been easy and pleasurable. There have been painful problems and hopefully positive recommendations can be made.

Problems and recommendations/comments

1 Knowledge and skills of educators: As this is a new learning area and most of the educators are not familiar with the content, much time and energy is spent on preparation and research. The effort needed causes the educator to become demotivated and it inhibits the educator's passion and enthusiasm in conducting a successful lesson.

Recommendations / Comments
With reference to the NRC, the educator envisaged in the new South Africa is a life long learner, scholar and researcher. Therefore it is important for the educator to continue to improve through independent research, seminars and workshops linked with other schools/areas. The South African Education Policy indicates that all educators are expected to do 80 hours of staff development per year. Educators must make use of available people and institutions as valuable resources and wells of information.

2 "Time and funding: A rare commodity": A general comment was made about the lack of funds to set-up and run a successful Technology department. Funding seems to be a problem in most of the schools, but more so in rural schools where learners are really managing with the bare minimum.

Educators experience pressure daily with marking, preparation and duties within the school. They need time to prepare and set-up a room for Technology, as very few schools have Technology rooms/centres. The lack of time to prepare and plan means that the Technology teacher either neglects to do a Technology lesson, or is not fully prepared for it – which could result in an unsuccessful and often negative learning experience.

Recommendations / Comments:
Team-teaching and co-operation among educators is the best way in which to save time. If educators work in groups to prepare lesson units, resources and equipment, time is reduced and the output is greatly improved. Preparation and organisation is the key to a successful classroom and the integration of technology in other learning areas or vice versa. The value of Technology education is undisputed. For this reason, it is essential that educators use time management to the best of their ability.

3 Understanding of learner outcomes as indicated in NRC: Comments were made that the outcomes were clear to most educators.

Recommendations / Comments
It is the responsibility of the educator to understand and find out how the outcomes should be reached and understood. Regional workshops need to be attended and contact made with people who understand the outcomes. The local subject advisor could be of great help in this area.

4 Learner outcomes which are difficult to understand or implement: Learner outcome 3, seemed to cause difficulty when trying to implement it. This learner outcome deals with the community and more specifically indigenous technology.

Recommendations / Comments
There is an indigenous background to almost every school whether it is an affluent or rural school, and the educator, with the assistance of the learners must highlight and explore the many possibilities that are available.
(Due to the nature of the presentation, focus will be on learner outcome 3, with specific focus on Indigenous Knowledge Systems.)

The point of departure is based on the premise that technology is a human response to a human need. Over the years, in different places, with different cultures, the basic needs remain the same but the responses differ.

Learner outcome 3: Technology, Society and the Environment

"The achievement of this Learning Outcome will ensure that learners are aware of:

- *Indigenous Technology and Culture: changes in technology over time, indigenous solutions to problems*
- *Impacts of Technology: how technology has benefited or has been detrimental to society and the environment; and*
- *Biases created by technology: the influences of technology on values, attitudes and behaviours (e.g. around race, gender, ethics, religion and culture)." (Department of Education: Revised National Curriculum* Statement Grades R-9, Technology)

What is "Indigenous Technology?"

Indigenous Technology and culture can be described as the rich cultural solutions to problems that have been provided by society (cultures). An example would be asking learners to find out about any remedy (home remedy) for a medical ailment, such as toothache, mumps, measles, cough.This information which may be traditional is a perfect indication of how people make use of Indigenous Technology by using materials that are easily accessible to them.

Kate Ter-Morshuizen (2003) stated the following re Technology and the Indigenous Knowledge Systems.

"The term indigenous knowledge is generally synonymous with traditional and local knowledge to differentiate the knowledge developed by a given community from the international knowledge system."

It has also been stated that one of the major problems with South Africa's curriculum has been that there has been an overemphasis on formal, scientific knowledge with absolutely no information on Indigenous knowledge. This is clearly a major form of bias, as the majority of South Africa's learners are indeed from an Indigenous background. Therefore, Indigenous Technology enables learners to cross the cultural barriers set by past governments' curriculum policy and to accept cultural and traditional remedies to a problem and create an understanding of how, why and what allowed them to arrive at the solution that they did.

The NRC indicates that Indigenous technology aims to enable learners to:

- "Explore, compare and explain how different cultures in different parts of the world have effectively adapted technological solutions for optimum use.
- Compare how different cultures have solved similar problems and look at the differences and possible similarities between those cultures and their own.
- Explain how indigenous cultures in S.Africa history have used specific materials to satisfy needs.
- Describe similarities in problems and solutions in their own and other societies – past, present and future.
- Recognise how products and technologies have been adapted from other times and cultures.
- Describe how local indigenous cultures have used scientific principles or technological products for specific purposes."

My understanding of Indigenous Technology is that it is a means to finding a solution to a problem by acquiring an eclectic collection of ideas from different cultures and using them, bearing in mind the environment in which those specific cultural groups live and making use of the materials and situations that they are exposed to.As Dr. Wally Serote stated: "There is a power, there is a strength, there is a wealth, there is a past, a present, a future, there is everything in the indigenous knowledge."

Engaging with Technology develops a learner's capacity for innovation, enterprise and invention. It stimulates curiosity and leads children to ask scientific questions and apply mathematical skills. After engaging with Technology, the positive effects are felt in Science and Mathematics.

"We need to challenge the culture of Technology to include Indigenous Knowledge Systems, so that the learners operate form a position of ownership and pride rather from a deficit position." (Kate Ter-Morshuizen: Technology and indigenous knowledge systems: September 2003)

It is important to note that none of the above mentioned problems should in any way prevent the implementation or growth of the Technology learning area in a school. They are merely obstacles to be overcome and need not have any significant bearing on the effectiveness of a technology lesson. Successful technology implementation is a process that takes time, dedication and enthusiasm. Successful Technology education does not necessarily take place in a Technology classroom but can be just as effective a learning experience in a rural setting under a tree where there are no walls or chalkboards.

Technology Education is being implemented. The painful process of getting systems in place, refining the rough edges of a bumpy start and the pain of implementing a new learning area now belongs to the past. Educators must now make every effort to enjoy the pleasure which this learning area can afford. Technology Education fills its rightful place in the South African curriculum.

"Technology Education can help us to design the future while building on the past." (Kate Ter-Morshuizen 2003)

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The Role of Technology in Our School Where Every Child is a Winner!

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Abstract

This paper outlines the development of technology education in one school in S. Africa. It is written mainly from the head teacher's perspective. The value of the subject is highlighted, the way in which it was introduced outlined, the development of its implementation discussed, and areas for future activity identified.

Designing the Future

The value of Technology Education in our school – the Head's perspective

Bredasdorp Primary School's success story begins with totally dedicated educators and Governing Body members who enjoy the wholehearted backing of parents, as well as the community at large. We strive for and implement advanced technology, to ensure quality education, realising that passion, commitment and hard work ensure success!

We believe that those countries which neglect education, neglect their future. It is important for us not to lose sight of delivering quality education in a time of transformation. It has always been of the utmost importance to us, to make our facilities and expertise available to all in our community, especially those members from historically disadvantaged backgrounds. Bredasdorp Primary School has shed the fetters and shackles of political, racial and cultural divisions.

Over the last couple of years Bredasdorp Primary School has forged close ties with schools, universities and foundations worldwide to ensure that our learners stay abreast of the latest methodology in education. Our school's educators have attended conferences worldwide. These visits have culminated in international networks that have greatly benefited the school and the local community.

The prescribed curriculum (Curriculum 2005/Revised National Curriculum Statement) that we are following in South Africa, is based on the Outcomes Based Education philosophy. It is an improvement on the curriculum that was implemented in South Africa pre-1994, when our country became a true democracy. We believe that if it could be funded and implemented correctly, South Africa would become a true competitor within the global arena.

To ensure that our learners are equipped to face the challenges of tomorrow, Christian principles, values and morals are interwoven throughout the lessons presented in classrooms. Furthermore there is an additional emphasis placed on the core subjects, with special reference to Mathematics, Science and Technology. We believe that Technology is one of the most important subjects that is taught in our school. If we succeed in inspiring our learners to develop their creative skills and can assist them by means of Technology to develop lateral and analytical thinking skills, our country, which is a Third World or a developing country, will prosper.

To ensure sustainability and to bench mark the progress our school is making regarding the implementation of Technology, the school invites guest speakers, foreign students and lecturers to the school, to help it keep abreast of the latest developments in the field Technology.

Our school has been specially indebted to Prof Clare Benson of the University of Birmingham in England and Mr Harry Valkenier of the Ontdekplek in the Netherlands. Both these passionate Technology Lecturers have brought students from abroad to our school. They have guided and inspired both learners and educators to greater heights.

To make Technology a fun filled exciting and relevant subject, we have in the past invited a Russian MI 24 attack helicopter, South Africa's own "Rooivalk" attack helicopter, as well as an Oryx military helicopter, civilian parachutists, our former national minister of education, Mr Kader Asmal and the world famous RAF Red Falcon Display Team to our school. They all touched down on the school's sports fields. This adds a new dimension to our school's activities where it is impressed upon our learners why they should apply themselves to certain subjects especially technology. In doing so we highlight the relevance of the subject and this approach assists the learners in coming to grips with the contents and skills that are associated with the subject.

Through these exercises our learners become happy and contented children that enjoy having fun while striving for excellence. It is our wish that our learners and by means of Technology will in future make their communities and the world a better and safer place!

Background to the school

Bredasdorp Primary School is situated in the Western Cape and in the Overberg region. There are approximately 614 children on roll including the Pre Primary classes. There are 290 children in the Foundation Phase (Gr.R-3) and 329 children in the Intermediate Phase (Gr.4-7). The Foundation Phase teachers teach Technology in their own classes and we have two teachers for the Gr.4-7 classes.

The Staff

We place value in technology education that it is learner centered and the teacher is the facilitator. We are passionate about teaching Technology. One teacher was identified as the key person and has attended numerous courses and conferences (internationally and nationally). Mrs Anne Barnard co-ordinates the teaching of Technology at our school. The two other staff members in the Intermediate Phase are highly motivated and share the successes in the Technology class with the other staff members. We build on the successes achieved. We have regular exhibitions of learners' work and feedback sessions. The principal and staff are committed to making Technology a success. We also link Technology to entrepreneurship and we have winners!

The value the children see in Technology education

Our learners know that at first their efforts will not be perfect, but as they gain skills they need, they are astonished at what they can produce. They like their work displayed for the staff, classmates and parents. They display the design brief and plans they have drawn up alongside the completed projects. They know that working together will built self confidence and improve self esteem as well as social and communication skills. They know that outside support from the parents, mentors, experts and other teachers is always available, you just need to ask. Our children realize that in order to reach their goals, they have to share their knowledge with others. They must assist, support, encourage and praise one another to achieve success. They also learn that group work is a valuable source of information and it allows them to:

- Work together
- Develop and build their confidence
- Share their enthusiasm and interests
- Learn to value their own opinions and judgment
- Develop valuable social and educational skills.

Our classroom

We have a room which are well ventilated with plenty of windows , blinds and it is tiled. We have painted the class and obtained help from a parent who is a creative artist to help us choose the colours. We have water, power points, work surfaces and enough seating, storage space, display areas, equipment and materials, pin-up boards, and whiteboards. If learners work in a room that is attractive, tidy and orderly, they will develop these traits too. They have respect for their work, material and environment. We try to promote a climate of creative inventiveness. The classroom is safe for the learner to operate in. We make Technology interesting and fun. Pupils attend it for one hour per week. Two teachers are also busy with extra classes in the afternoons.

How the development of the subject has been undertaken

A few years ago there was no technology at our school until the implementation of OBE. With OBE we had to begin developing the area of Technology from scratch. I met Prof. Clare Benson at a national conference in Cape Town a few years ago. We decided to build bridges together and so she visited us and brought some students with her. I attended two CRIPT Conferences in Birmingham which I enjoyed and learnt from. At one of these conferences I met Mr. Harry Valkenier and he consequently decided to visit us in Bredasdorp. Two of Africa's most sophisticated technological centers are to be found at the Southern most tip of Africa. The one is OTB (Overberg Missile Test Range) and the other one is TVOS (Test Flight and Development Center). These two centers play a vital role in aeronautical research and foreign countries come here to test their missiles and aircraft. We too frequently visit these facilities with our overseas visitors and they find it fascinating and interesting.

The future...

- Establish links and network with groups worldwide.
- Share intellectual resources via e-mail and our website on the Internet.
- Annual national and international conferences e.g. PATT, CRIPT.
- Expand our afternoon classes to their full including neighbouring schools and or community.

A Consideration of the Triad of Impairments for Pupils with Autism in Relation to Pupil Learning in Design and Technology

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Abstract

Sutherland House is a specialist provision for pupils with autistic spectrum disorders. Autism is a complex lifelong condition that affects the development of communication, social and life skills, impacting on how a person makes sense of the world around them.

People with autism share a triad of impairments: impairment in language and communication; impairment in social skills; and a rigidity and inflexibility of thought processes (Wing 1996) and though it is difficult to accurately judge a true level of intelligence (Christie 1990), both this and the severity of autism vary from child to child and even for the same child over time, creating a wide spectrum of ability and need. Sutherland House caters for the needs of pupils across the whole spectrum, though the majority have significant and complex learning difficulties in addition to autism.

Introduction

The school aims to keep pace with national developments whilst addressing the core areas of communication, social and life skills. By the time the National Curriculum included a statement on inclusion in 1999, development of schemes of work to meet the diverse needs of our pupils had begun.

The scheme of work for design and technology aims to ensure that all relevant aspects of the programme of study are covered during a three-year topic cycle, as well as ensuring progression and continuity of activity and experience across the school. Units of work prescribe learning outcomes and suggested activities for pupils, ensuring differentiation and continuity across the key stages. Though the scheme was written prior to the publication of the QCA materials, these are being adapted and included where appropriate, as revisions are made. As with all other curriculum areas it is essential that the teaching of design and technology be informed by a secure understanding of autism.

Though the skills the National Curriculum recommends be developed and built on through design and technology this presents something of a challenge with reference to the Triad of Impairments; much of what is written about the teaching of design and technology in mainstream environments applies equally to pupils with autism:

- It should provide opportunities for children to engage in activities that are challenging, relevant and motivating (DfEE/DATA 1996);
- It is always purposeful (Interim Report of the National Curriculum Design and Technology Working Group 1988 cited Makiya and Rogers 1992);
- It involves solving practical problems within contexts that have meaning and relevance to pupils and that are within their capabilities (Makiya and Roberts 1992).

Children who are developing normally learn instinctively and incidentally; they have enquiring minds that absorb learning and build on existing skills. They arrive at school with expertise in many areas including solving problems and finding meaning in their surroundings. According to Archer (1992) there is evidence that the human mind is predisposed to make sense of experiences and perceptions in particular ways, forming conceptions that are common to all.

We cannot rely on children with autism having the same, shared experiences. There appear to be differences in the way they perceive stimuli from the environment (Powell and Jordan 1997), for example certain sounds may cause pain or extreme distress for pupils. Sensory experiences and perception may not only differ from the 'norm' but also fluctuate in intensity and this can prevent the child from forming generalisations. The impact of the Triad of Impairments is far reaching, influencing all areas of learning. It makes access to design and technology a particular challenge, though an exciting one. This study will look at each of the impairments in the triad and consider how each impact on learning in design and technology. It makes reference to the work of a group of six Key Stage 2 pupils (aged 7-8) who are working between levels P4 (pre National Curriculum level) and level 1 of the National Curriculum in English and Maths.

1 Impairment of Language and Communication

Language may be defined as a system of communication. DATA (1999) define it as "a tool for thinking and communicating". Children's ability to use language influences their learning across the curriculum. Though it is a failure to use language for communication that characterises autism, pupils also often have specific language difficulties. In addition approximately a third of children develop an early vocabulary and then lose it and half of all children with autism are said to fail to develop functional speech (Howlin, 1998 reporting Lord and Rutter, 1994 cited Sutherland House 2000).

The impairment of language and communication affects the ability to understand and use all aspects of both verbal and non-verbal communication and includes the pragmatics of language, eye-contact, body language, facial expression, social timing: those aspects that underpin how effective we are as communicators. In an area of the curriculum so bound up with communication these difficulties present a significant challenge to learning.

We must ensure that our pupils understand the things we are saying to them and the expectations we are making of them. There may be a variety of reasons, such as poor auditory memory or difficulty in 'zoning out' irrelevant background stimulation, why pupils with autism have difficulty in understanding and responding to the things we say. Careful thought must always be given to ensuring the greatest level of understanding possible based on our knowledge of the needs and learning styles of individuals within the group. Using language that is clear, concise and unambiguous is essential. Constant thought needs to be given to the amount and type of language that we are using. Even those pupils with good understanding are likely to make literal interpretations of our words.

Warren and a member of staff were 'chatting' about a recent visit by his grandparents:

Teacher: "Do you see a lot of them?"

Warren: "No, only two."

Many pupils with autism are visual learners and systems of visual clarification are essential. At Sutherland House signs and symbols are generally drawn from the Makaton vocabulary with Rebus and PCS filling gaps. It can be difficult to find appropriate symbols for the materials and concepts used in design and technology and we may have to think laterally in order to come up with ones that meet our needs.

In focussed practical tasks clear visual models of our expectations in a 'Here's one I made earlier' way show pupils what we want them to make, helping with 'central coherence' or understanding of the whole. Rigidity and inflexibility can however create a tendency to replicate these in an exact way. Demonstrations of parts of the task can help the pupils to understand what they need to do, but it is essential to ensure that attention is engaged, whilst taking into account that for some pupils peripheral vision is more effective. Throughout sessions it is often necessary to provide direct reference to models at varying stages of completion and repeated demonstrations of what is being expected.

Lists of written instructions supported by symbols are permanent., unlike words that last only moments. They can be referred back to as many times as necessary and facilitate a greater level of independence in those pupils who are able to follow them. Written instructions can also prove useful to support staff who can refer to them in order to facilitate pupils working at their own pace (Figure 1).

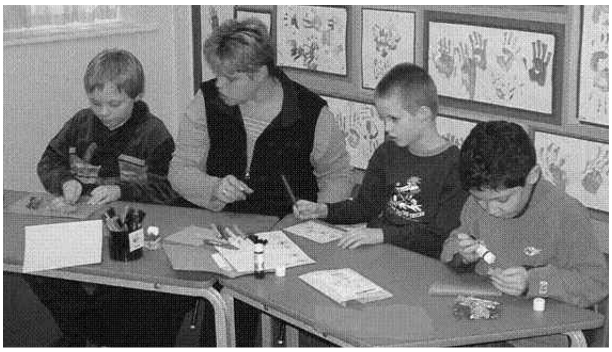

Figure 1

Though we have attempted to introduce appropriate 'technology vocabulary', some of the concepts are difficult for our pupils to understand. Evaluation involves asking questions and making value judgements about products. In order to make evaluation accessible it is necessary to structure the 'design brief' and criteria for success very tightly, keeping judgements to a minimum. Criteria need to be concrete, specific and easily assessed.

Much of the guidance material for the education of pupils with autism details the importance of choice making, self-advocacy and expressing preferences. (DfES 2002. NIASA 2003). These skills also provide the beginnings of competence in designing which involves the interaction of both thinking and action (Ritchie 2001). In order to make a choice one must consider the alternatives and Temple Grandin (1986), an extremely able adult with autism, describes the difficulties she has in holding one piece of information in her head whilst manipulating another in order to make a choice. We aim to provide visual, structured choices from a restricted range and to differentiate our expectations according to the abilities of the individual.

David is able to make a choice from all the materials and equipment provided, selecting independently as he works his way through each task. Jack on the other hand, is offered a choice of two alternatives and these are brought to him in his seat at the table. Expectations for Lawrence are differentiated according to his fluctuating mood, which impacts on his level of frustration and ability to make choices.

Normally developing children gain an understanding of what other people think and feel (Theory of Mind). Children with autism have a marked impairment in this area, which is likely to impact on skills in many areas including that of communication. Pupils may develop spoken language skills in advance of and often in the absence of the ability to communicate (Jordan and Jones 1999). They are not motivated to communicate perhaps because they do not realise that others do not know the things they know and therefore do not understand the need to share information (Jordan and Powell 1995). Where pupils do communicate it is invariably directed at having needs met, rather than sharing information or interests (Jordan 1999).

2 Impairment in Social Relationships

The social relationships of pupils with autism are defined by Jordan (1999) as being "impaired, deviant and extremely delayed". At the very least pupils show "an underlying lack of social interest and awareness" (Jordan and Powell 1995). Learning invariably takes place in a social context and is therefore beset by difficulties for the pupil with autism.

At the heart of their difficulties in this area lies a lack of social empathy. Social empathy makes it possible for us to understand something from another person's point of view. It allows us to develop a concept of another person who may or may not share the same experiences and thoughts as ourselves. However Hobson (1993 cited Jordan 1999) suggests that people with autism lack the concept of another as a person like themselves, who might share the same kind of mental experiences.

This therefore presents a significant challenge when considering the needs of another when making a product for a particular user. As with young mainstream pupils the needs of the user have to be concrete and easily measurable. Even when pupils have been involved in gathering specific information using a simple questionnaire they may not understand the need to consider and use this information when designing their product.

> *Pupils were involved in taking home a 'letter for mummy' to ask her preferences in colour and flower in order to design a Mother's Day card. The letters were looked at in detail with each pupil individually when they were returned to school and the importance of the information stressed in relation to the task. This was repeated at the beginning of the session. Though Sam understood the nature of the task and was able to indicate from the letter his mum's preferences, he still selected his favourite colour and flower to make the Mother's Day card.*

Normally developing pupils are motivated to learn in many ways. They enjoy the social rewards that learning brings and even if not directly enjoying a particular activity, may be motivated by a desire to 'please the teacher' or by the long-term goal of success. This is not generally the case for pupils with autism and we may need to think carefully about how we can make activities intrinsically motivating in order to capture their attention.

> *When making hinged flaps, pictures depicting a range of favourite cartoon characters were used. All the pupils were able to choose a character that appealed to them. John showed his best levels of attention during this session and in subsequent sessions was looking at materials spontaneously for the first time.*

Shared understanding and attention are key to learning. There is evidence that children with autism do not spontaneously look where others are pointing or direct their gaze to objects that are held out for them to look at (Jordan and Powell 1995). In design and technology sessions, if a pupil is to know what is expected of them they must first watch and share with the teacher a demonstration. Arranging seating so that attention is naturally directed to the front combined with animated visual delivery that does not rely on language can help. Experienced support staff can further guide and focus pupil attention. An animated delivery may also be rewarded by shared enthusiasm.

Sutherland House operates a key worker system and pupils have one hour per day of individual work time with their key worker. A calm and consistent approach, combined with clear framework of rules and pleasant experiences enables the development of relationships (Wing 1996) and over time many pupils do develop strong, trusting relationships with adults in school. These relationships are particularly important when expecting pupils to learn as part of a group.

> *Moving Sam to sit next to Kim with whom he has a strong relationship enables her to give him direct support and encouragement when she feels he needs it in order to help him achieve success. Sitting next to her gives him increased confidence in his own abilities. He knows that he can ask for reassurance about the things that worry him.*

A full knowledge and understanding of both autism and the needs of individual pupils are key. Learning as part of a group means that pupils may have to sit alongside peers who may be unpredictable in their behaviour. Though challenging behaviour is dealt with calmly and quietly in order to lessen its impact on the other pupils, worry about the prospect of sudden outbursts of noise or challenging behaviour can impact greatly on ability to concentrate on the task in hand.

> *Answering Sam's constant questioning about John's noises (even those that are happy ones) enables him to worry less about them. The trust he has developed allows him to give greater attention to his work.*

The impairments within the Triad overlap and impact on each other and whilst we cannot remove all the social aspects of learning as we can change some. Providing clear visual structure, written instructions, developing independence skills etc all contribute to removing some of the additional stresses of learning.

3 Rigidity and Inflexibility of Thought Processes

In order to learn effectively children must be comfortable and relaxed. At Sutherland House careful thought is given to structuring each learning environment in order that it reduces stress and enables learning. As in mainstream classrooms, workspaces are multi-functional and in order to provide a clear indicator to pupils of what they will be experiencing, the workspace organisation is slightly different for each curriculum area. Providing a consistent visual structure of furniture/seating etc that directs attention to the front and that makes it easy for pupils to plan their movements when collecting materials helps them achieve a greater level of independence. Clear organisation can also ensure the best combinations of pupils and appropriate placement of support staff (Figure 2).

Figure 2

Children with autism find it hard to "organise themselves in time and space" (Wing 1996). Providing a written/symbol list of the equipment needed for each task and guiding pupils to collect each piece of equipment and place in a basket to facilitate carrying can allow them to develop the confidence to collect materials independently later. Naturally levels of support given will be differentiated according to need.

Whilst some pupils may continue to need support for some time, Pupils with autism can quickly become dependent upon routines and structures and we can unwittingly increase their rigidity and dependence upon prompts. This level of prescription also fails to allow pupils to make their own decisions and maybe even mistakes about the appropriateness of a particular tool for a task or the materials they will choose. Giving clear demonstrations of the skills/tools involved, a teacher-led disassembly and evaluation of the materials and then differentiated levels of support develop and encourage a greater level of independence.

> *It was interesting to observe the increased confidence of pupils over the weeks. They developed their own strategies for collecting materials and components; David collected everything he needed in one go, making sure he got the colour/picture etc that he wanted before anyone else; Sam collected just enough for each element of the task and needed some guidance to stand up again and move onto the next; Rasik checked carefully with an adult to ensure that he was making the right decisions.*

A difficulty in the generalisation of learning is a key feature of autism. Skills learnt in one situation are not easily transferred to another and may indeed have to be continually relearned as new skills. In the light of this and the difficulties that children have in experiencing events as happening to themselves and in recalling events in which they have been involved (Jordan and Powell 1995), photographs could be taken of each pupil carrying out tasks to provide cues for subsequent sessions. However this can quickly become unmanageable in practical terms. Instead, a model prepared by the teacher and pieces of pupils' work showing a concrete example can be used successfully to cue memory.

All would no doubt agree problem-solving is an inherent part of design and technology. Makiya and Rogers (1992) refer to three different types of problem:

- Closed problems in which a specific answer is required and the process of solving the problem is often immaterial;
- Technical and investigative problems in which there may be a series of solutions some of which may be better than others and where the problem-solving process is important;
- Open-ended or design problems in which there may be many good solutions and where the criteria for evaluation are both objective and subjective.

Rigidity of thought means that problem-solving is likely to prove difficult for pupils with autism who may not even recognise that a problem exists. The need to solve a problem has to be intrinsically important to the child.

> *John is able to work out that in order to open a locked door to retrieve a Pingu comic, he needs to fetch and stand on a chair in order that he can reach the thumb-lock. Involved in design and technology sessions he is able to work out the quickest way of reaching the basket of tissue paper before an adult in order that he can throw the paper in the air and watch it float down. When asked to choose between glue and sellotape to stick down pieces of scrunched paper he does not understand what is being asked of him.*

Those who attempt to solve problems take risks. If the attempted solution is not successful we may need to adopt another strategy based on our consideration of the alternatives. According to Ritchie (2001) "effective problem solvers use a range of approaches that are dependent upon the circumstances of the problem solving situation". Pupils with autism tend to use "set approaches that have been successful in the past" (Jordan and Powell 1995). They find failure especially hard, perhaps because they do not know what to do if a strategy fails. Their activities often involve significant repetition along with the rigid performance of set routines (Jordan 1999). They are likely to obsessively arrange components into lines or attempt to spin them rather than explore their wider properties or investigate how they could be put together.

> *Christopher is quickly distracted from the task by holding a glue stick lid in front of his eyes and observing the slight movements made against the patterns on the ceiling. When an adult intervenes he becomes upset and cross and it takes some while to involve him in the task once again.*

In order to facilitate problem-solving it is necessary to structure problems in such a way as to allow the pupils to take risks, whilst ensuring support to achieve success. This requires not only a sound understanding of autism, but also an in-depth knowledge and understanding of each of the pupils.

Based on her knowledge of Lawrence's abilities and the outbursts of challenging behaviour likely to ensue if he becomes frustrated, Kim differentiates the problem of cutting a flap the right size to cover a picture. Instead she presents him with three pre-cut flaps and helps him to investigate which one provides the best fit. Clear use of simplified language and signs help to focus his understanding of the problem and by the end of the session he is able to select flaps independently.

Design and technology involves pupils in making products within certain pre-set constraints. The constraints set will of course vary according to the needs and abilities of the pupils within the group. The evaluation considers how well the end product meets the criteria that were set. It is complex as there may be many possible 'good solutions' with criteria that may be both objective and subjective (Makiya and Rogers 1992). Designs are then refined in the light of the findings. Children with autism however "do not usually learn successfully by their mistakes or by trial and error" (Cook and Golding1998). Evaluations must necessarily be made as concrete as possible and the 'design brief' therefore be very precise.

Children without autism are likely to explore everything they come across with open-ended questions, which they have the potential to extend without limit. The child with autism quickly learns about those things that serve his/her obsessions but then shuts the door on future learning. (Newson date unknown). As pupils do not spontaneously explore materials or 'disassemble' objects to see how they work it is necessary to structure this activity into the beginning of sessions (and throughout focussed practical tasks) and to guide pupils through the process.

When involved in guided evaluation of the best fastening for a figure with moving limbs, most of the pupils find it quite straight-forward to judge whether limbs are able to move and to reject those fastening that do not allow movement. Making a value judgement about which fastener provides the best movement needs a greater level of support. Over-acting on the part of the teacher with a staged rejection of the fastening by support staff demonstrate fasteners that make the limbs too 'flippy-floppy'. However some of the pupils find it difficult to use this information when making moving figures of their own. It is interesting that although Christopher is able to reject the bulldog clip he uses all of the other fasteners in his work.

Conclusion

Ritchie (2001) considers it difficult to provide a simple definition of designing. He states that it involves a selection of skills that, due to the nature of autism, present a huge challenge to our pupils:

- Thinking creatively;
- Generating, developing and communicating ideas;
- Compromise;
- Reflection;
- The application of previous experience and technology;
- Restructuring of ideas;
- Planning;
- Communication skills.

It would be easy to therefore dismiss this area of the curriculum as one that we are not able to access. It is important to remember however that pupils with autism also have great strengths and a more recent move to viewing them as having not deficits, but a different perspective and experience of the world encourages us to place greater emphasis on their strengths and abilities (DFES 2002). The adult's role is critical in breaking down each problem into pieces that are manageable and in providing support differentiated to meet the needs of each individual (Figures 3 and 4).

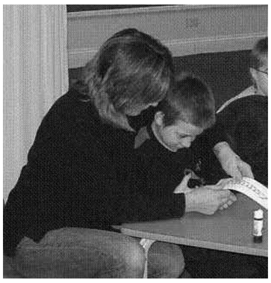
Figure 3

Pupils with autism can make excellent progress in design and technology. The subject, delivered in such a way as to enable pupils to access it to the best of their ability, provides a vehicle to boost and develop self-esteem, independent learning, choice and advocacy.

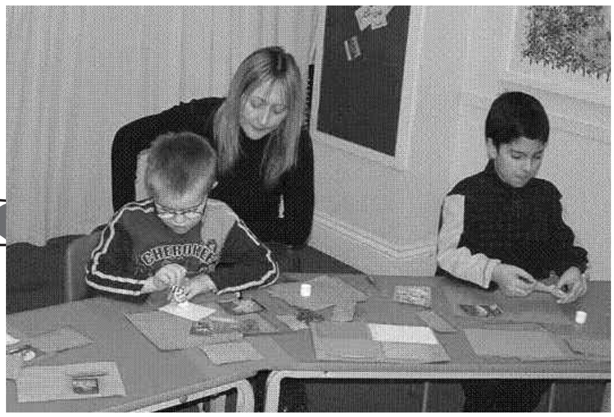

Figure 4

The unit of work referred to in this study culminated in a task to design and make a moving picture to add to a text for Group Literacy sessions. Each of the sessions leading up to this, focussed on a discreet practical task that aimed to develop pupil skills, knowledge and understanding of a range of mechanisms.

Video evidence clearly shows the increase in pupil confidence over the series of sessions and 'Monitoring of Teaching and Learning' by the head teacher in week 5 states "Pupils clearly understood what to do and how to get help if needed". The fact that pupils become relaxed enough over the weeks to 'chat' with staff and even on occasions with each other as they work, highlights the importance of providing an appropriate scaffold of support, based on an understanding of the learning styles and needs of children with autism.

The pupils in this group are developing their 'design competence'. All are able to make structured choices to influence the development of their work. Each pupil was able to choose, from photographs, which mechanism they wanted to work with and to select symbols representing the equipment they would need. Planning was also structured using symbols as pupils sequenced the steps of their chosen task. Sam and David were able to discuss some of their ideas in preparation.

Though the work of the pupils was based entirely on what they had been taught in previous sessions, they were able to make choices from the full range of resources and to combine materials from different practical tasks showing an element of flexibility and creativity). "Pupils showed pride in their achievements" (Monitoring of teaching and Learning).

> *"Teachers should aim to give every pupil the opportunity to experience success in learning and to achieve as high a potential as possible."* (DFEE/QCA 1999)

> *"Design and Technology makes a crucial contribution to the development of pupils' practical and thinking skills . . . . It is this essentially practical aspect that makes design and technology an attractive and valuable learning experience and environment for pupils of all abilities."* (Curriculum Council for Wales 1993 cited Davies 2004).

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What We Really, Really Want

D&T book author, inventor, teacher and MD of Kre8 Products Ltd.
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D&T Teachers Role

As D&T teachers we are expected to produce students who can be : – innovators, creative problem-solvers; adaptable, employable and discriminating users of technology. We want to enable students to be creative, appreciate aesthetics, improve the quality of life, work autonomously or as a team member, to be able to combine and use skills, and consider the impact on society and the environment with rapidly-changing technologies.

As teachers and students we do this by:
Note – The words in brackets refer to alternative terminology used in Australia – just for interest.

- Exploring ideas (Investigation)
- Generating ideas (Ideation)
- Developing ideas (Production)
- Planning work (Production)
- Evaluating (Evaluation)
- Questioning
- Apply skills and knowledge
- Simulating situations
- Using 2D models
- Explaining
- Refining
- Explaining
- Testing
- Trying ideas out
- 3D modeling
- Making mock ups
- Making prototype models
- and other techniques

Traditionally resources used that try to achieve this consist mainly of representing ideas on paper or on screen because 3D methods are too difficult to make or organize. If 3D modeling is undertaken it usually means making use of: – Paper and card – good but has many limitations; Reclaimed materials – variable and unreliable; Clay or similar – messy and takes time; Construction kits – expensive and only offers fixed sizes.

So what, as a teacher, do I really, really want

While writing my D&T textbooks I had to produce many illustrations and pictures to show technology teaching in action. It really was very time consuming as there was not an easy, fast, economic, versatile modelling medium available so I had make hundreds of models using whatever seemed best at the time. A Eureka moment came when I realized a now patented connector with an integral hinge could help. I refined the basic idea adding new features such as the ability to hold rods, tubes and sheet materials. At this time I could not tell anybody about the potential of this breakthrough, unless they signed a non-disclosure agreement. Gradually the idea developed into a comprehensive making and prototyping system, which I

Why Kre8

Disadvantages of typical construction kits	Advantages of Kre8 making system
• Expensive	• Very economical
• Animated structures are difficult to make	• Animation capability is built in
• Not supposed to be cut, drilled and glued	• Can alter parts as YOU want them
• Lots of specialist parts needed	• lJust a few part required
• Time wasted looking for the right part	• Easy to select part wanted
• Fixing connecting places (e.g. rows of holes)	• Fix parts were you want
• No way to add card and sheet material	• Slots to add sheet and card
• Fixed length blocks or strips	• Can cut rods to required length
• Packing up can be very slow	• Packing up is fast
• Students have to share kits and tidy boxes	• Students can have own bag of parts
• Specialist angle connectors	• Adjust connectors to angle wanted
• Overlapping joints cause build up	• Parts do not overlap
• Making in situ adjustments can be impossible	• Easy to adjust parts in situ
• Not very suitable for light structures	• Can make kites that fly
• Over designed parts making models heavy	• Light models
• Stock control is a nightmare	• Stock control is very easy
• Not interned to be used with other kit	• Designed to be used with other kits
• Dropped models can fall apart	• Can be thrown about – little damage
• Expensive support or booklets	• Free extensive support via web site
• Cannot join structural parts end to end	• Can assemble 2D shapes in-line and flat
• Only dedicated electronics parts used	• Standard PCBs etc can be used
• Not cheap enough to take home from school	• Can be taken home and parts re-used
• Not considered a consumable item	• Use as a consumable item if wanted

registered under the trademark Kre8®. A major decision before mass production started was the size to make the kre8® connectors. It was decided to go for maximum compatibility with other construction kits used in schools.

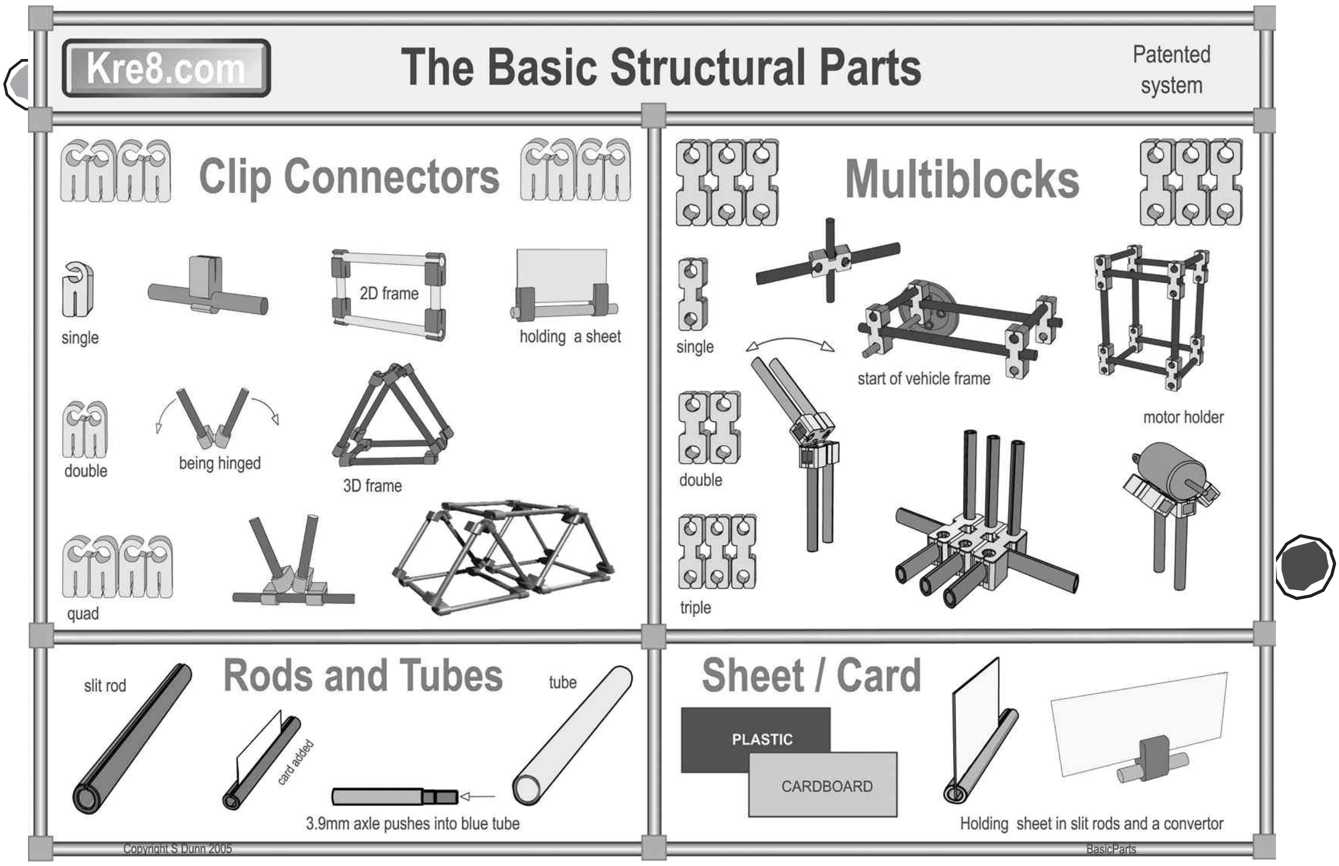
Whilst still searching for a suitable plastics production company and sales distributor I developed a complete Kre8® mechanisms set. And finally to ensure robots and advanced models can be made easily I added a Kre8® converter piece that allows standard electric and electronic parts be incorporated easily. Luckily I won a large award from NESTA (The National Endowment for Science Technology and the Arts) which has enabled the Kre8® system to be made in the UK.

What is so new about Kre8

It revolutionizes the way design can take place as there is now almost nothing you cannot model using the Kre8® Making System. Other kits tend to limit the user and are far too specialist for open-ended work or prototype work.

Most of the design and make techniques required in the D&T curriculum can include the Kre8® making SystemBelow are examples to show how:

- Explore ideas –
  e.g. explore ideas by making various Kre8® monster insects
- Generate ideas –
  e.g. by modeling various Kre8® vehicles
- Develop ideas –
  e.g. add electrics onto a Kre8® product display stand
- Plan work –
  e.g. photograph the steps in making a Kre8® weighing scale model
- Evaluate –
  e.g. by using, testing and modifying a Kre8® kite
- Question –
  e.g. answer questions about a Kre8® model's performance
- Apply skills and knowledge –
  e.g. make a Kre8® mechanical model
- Simulate using models –
  e.g. model a Kre8® playground see-saw
- Model a problem –
  e.g. model windscreen wiper mechanism using Kre8®
- Explain –
  e.g. explain how your Kre8® bridge was made and how it works
- Working model –
  e.g. make a working Kre8® robot to follow a line
- Refine –
  e.g. refine a model Kre8® structure by easy repositioning parts



Basic Kre8 parts – This shows just the basic structural parts of the Kre8 invention and various ways in which they can be used.

- Test –
  e.g. have a competition using Kre8® mangonels to hit a target
- Try ideas out –
  e.g. model a large concept Kre8® football stadium
- 3D modeling –
  e.g. make a Kre8® fairground ride
- Quick mock up –
  e.g. make a Kre8® fold up chair
- Prototype –
  e.g. make a toy spinner with Kre8® parts
- What if? –
  e.g. what happens wheel size is reduced on a Kre8® robot
- Consider abilities and ages –
  e.g. make a Kre8® model playpen

Supporting the Core subjects

There is strong support for numeracy as the Kre8® parts often require measuring and need to be cut to size. These parts are then assembled in all sorts of mathematical forms.

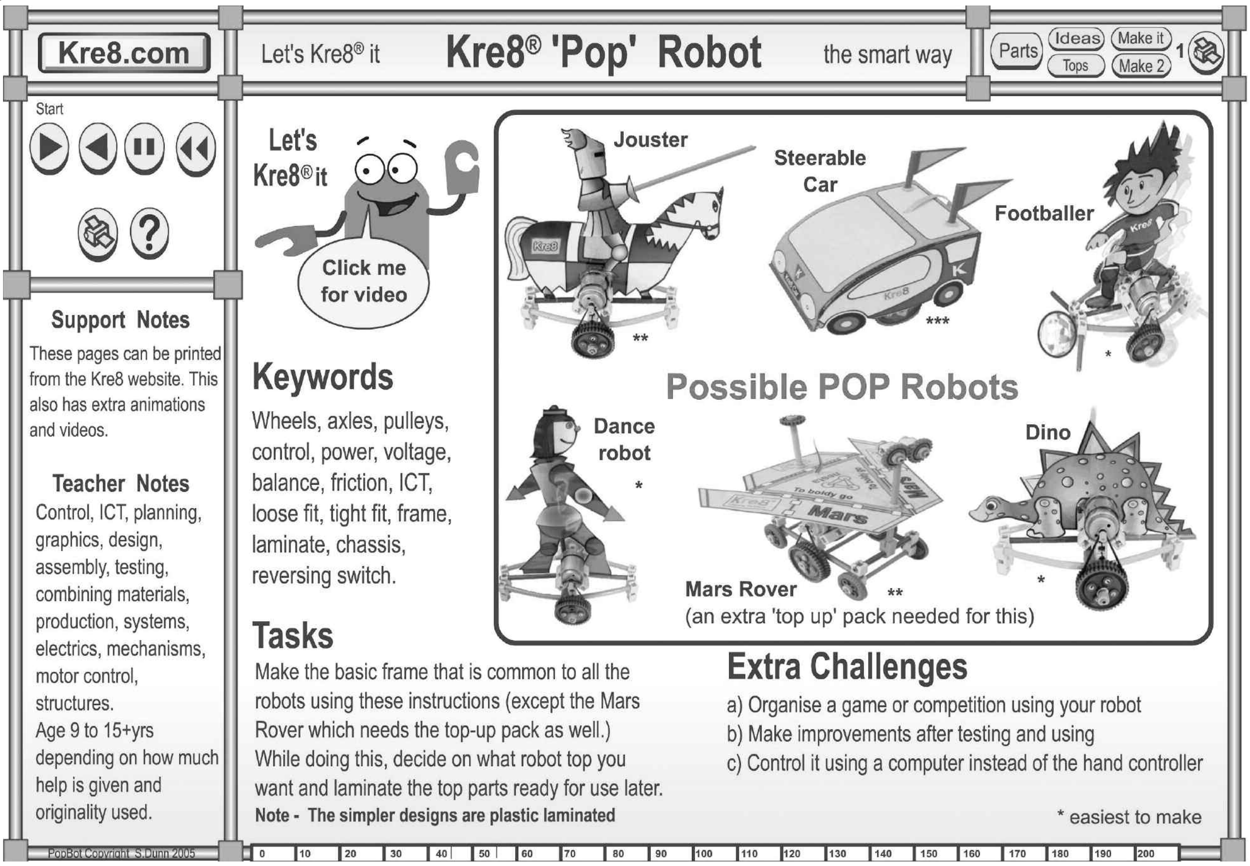
The natural links with science are: – forces, stability, electricity, materials, movement and mechanisms Many aspects of ICT can be covered including: – control, programming, research, CAD, CAM, Data handling. Kre8 can be used to support this work as it is carried out.

Kre8 naturally encourages literacy in a practical context; the development of speaking and listening skills occurs whilst students design and make. Reading is required with the various forms of support materials and instructions. Various forms of writing skills are practiced to support the design process from note taking to preparing a presentation.

The story so far

It is proving especially popular for activity days where 20 to 30 models are used with a class or 150 to 200 models for a whole year group when undertaking a fun technology activity day or similar. Some use it for gifted and talented booster maths and science classes while others use it to help the less able. The most popular model last year was the Kre8 Mars Rover robot. This has now been developed into the more versatile POP robot. To support the user an advanced website now supports new developments and it also includes an easy to use database of over 1000 of the best D&T websites.

We like to work on new projects with organizations and can produce bespoke solutions. Universities such as the Open University have actively taken this up for use with their outreach work in libraries, shows and schools. +



Pop robot – The front page of the latest Kre8 POP robot which can be seen on the Kre8 website at www.kre8.com sitemap > Kre8 robots > pop robot.

Enhancing Primary Teacher Trainees' Understanding of the New Zealand Technology Curriculum through the Utilisation of Community and Enterprise Links

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Abstract

As a lecturer who has long been involved with Technology Education (Years 1-8) pre-service programmes, I have worked closely with students endeavouring to comprehend the content and expectations of this curriculum prior to implementing it in classroom practice. One significant concept explicitly promoted in the New Zealand Technology Curriculum document (1995) is that of the use of community and enterprise links to enhance school technological practice, and it is this particular curriculum recommendation that has been emphasised for the benefit of our second year Technology students.

This paper presents an overview of our second year Technology curriculum course with a particular focus on how our students benefit overall through involvement with various community and enterprise operations. A number of facets of the New Zealand Technology Curriculum will be presented and these will be illustrated and highlighted with reference to a selection of 'businesses' that students have visited and investigated. A more in-depth exposition of key curriculum aspects will be presented with reference to one specific case study, namely the 'Happy Hens' enterprise.

Background

The first year Dunedin College of Education course in Technology is designed to introduce students to the overall structure and content of the curriculum in a general sense, with a particular emphasis on engaging in some practical in-class tasks with a 'gentle' focus on a number of the seven stated technological areas. For example, students work can involve basic electronics and control, biotechnology, structures and mechanisms, food, materials and information / communication technology. With lecturer assistance they also plan and later teach, two to three linked lessons in technology on their subsequent placement in schools. The students also need to begin developing an appreciation of what technology was, is and could be, especially within the setting of New Zealand society. In other words, they begin to get a feeling for technological literacy and what this can involve.

By the beginning of their second year course the students are able to reflect and comment on the curriculum in a general sense, but there is a proven need to help the students obtain a more in-depth understanding of significant curriculum elements to further their teaching competence and confidence. These elements include the holistic nature of the three technology strands along with the embedded achievement objectives, the essential skills, technological areas, contexts, health and safety issues and the characteristics of learning in technology. The very important characteristic of authenticity in technological practice is also presented and reinforced through a variety of in-class tasks.

Utilising our local community resources has been a most successful method of not only giving the students a solid base in their curriculum knowledge but also a realistic appreciation of how this learning area is very real and linked strongly to everyday life and human endeavour. As the curriculum document states:

> *"The link between schools and the community, including business and industry, tertiary institutions, and local authorities, is important to a well developed, inclusive technology curriculum. Outside experiences enhance, reinforce and clarify classroom learning."* (Technology in the New Zealand Curriculum (TINZC), 1995, p.17)

Dunedin is a small city of around 120,000 people, but the variety of businesses and enterprise operations the students manage to access is quite extraordinary. Over the last few years businesses visited have included Cadbury's, screen printing firms, a worm farm, pizza and pasta producers, fast food outlets, plant nurseries, paper manufacturers, instrument makers, fashion designers, water purification plants, a doll maker, jewellery designers / producers, a resource centre for the visually impaired, recycling plants, florists, sign writers, bakeries, a flag maker, a pickled onion and preserves factory, salad production, printers, beer brewing, snow making, dairy factories and New Zealand Post. Some of these operations are large while others like the 'Happy Hens' which will be presented as a case study later in this paper, are small.

Introduction – Some Foundation Issues

Technological Literacy

The achievement of *technological literacy* for students is a stated aim of the curriculum (TINZC, 1995, p.8) and again the use of business or community resources is a wonderful means of placing this 'target' in a meaningful context. Dr Alister Jones expands on the concept of technological literacy when he writes of "the (students) exploration and solving of complex and interrelated technological problems that involve multiple conceptual, procedural, societal and technical variables." (Jones, 1997, p.3) Business and community enterprises have to do exactly this to survive and flourish and students quickly pick up on this point as a result of their investigations. Rasinen (2003) describes technological literacy as a 'universal goal' and adds the further ingredients of 'social, moral and ethical thinking along with innovativeness and entrepreneurship' to the mix. Coming to a personal understanding and appreciation of the 'width' of technological literacy in an educational sense is not straightforward but it is very important for students in pre-service technology education programmes.

The crucial notion that Technology Education is not just an add-on subject at school but is a significant area of study that relates to real life ties in very closely with technological literacy. Our students readily develop an appreciation of these 'real life' links and this is reinforced wonderfully through their interactions with the various enterprise settings and people they meet on their visits. For example they commonly learn how particular needs, problems or opportunities have been initially identified and then how the enterprise solved or met these as a vital part of their business success. They also observe people applying a range of *essential skills* (TINZC, pp.18-19). Examples of these would be problem solving, numeracy, information / communication, social / cooperative practices and physical skills all observed in a real, working situation. They learn about the importance of thorough and realistic planning, of recognising constraints or limitations and that evaluation has to be all encompassing and ongoing. They also have to consider health and safety issues and how these might impact on their own or children's technological practice. A very applicable point was made by Thomson (2004):

> *"Technology education can be defined as that part of the curriculum concerned with helping learners to become technologically capable: to identify human needs for which technological solutions are possible, design and make appropriate products (physical products or organisational systems), and to evaluate their quality and their potential societal and environmental effects."*
> (Gardner & Hill, 1999, p.104)

One local teacher illustrated the above points beautifully when she utilised a local gardening centre, hardware business and other visiting 'experts' to help her junior class research and then decide whether it was going to be possible and worthwhile for them to develop their part of the school grounds which they had identified as needing improving.

This humanistic, social and environmental side of technology and technological practice is at the heart of technological literacy and to impart the essence of this to the students vicariously would be extremely difficult. Through students undertaking the close examination of a business, community or even home-grown enterprise, the 'people and society' link to technology becomes very self evident and comes through strongly in their seminar presentations.

To quote from Eggleston (1997, p.28):

> *"It is this socially-sensitive concept of technology and design that is at the heart of design and technology education as it is developing in the schools."*

Technological Knowledge

An important outcome of these community engagements is the increase of student's *knowledge* about some specific aspects of technology and technological practice which as Moreland, Jones and Chambers (2001) state, 'this core knowledge is pivotal for effective technology teaching'. Alongside this development of technological knowledge comes the significant notion that the students should be able to link this knowledge to the 'social' side of technology, rather than treating it in isolation. Compton (1997, p.67) makes the point that:

> *"knowledge itself cannot be abstract or neutral but rather reflects the complex interaction of values and power structures embedded in the social matrix within which it was constructed."*

She also adds that in order to 'develop inclusive technological practice' there is a need to be able to 'position knowledge in a social context'. Seeman (2003) speaks of the importance of not only the 'know how' but the 'know why' of technological knowledge and cites Dewey (1963) who examined extensively the place of knowledge in schooling and spoke of the 'interconnectedness of knowledge' being a key feature of education.

It is also important that students observe technological knowledge being linked to technological practice and as expected this 'partnership' is readily observed during their community visits. Jones, Carr and Mather (1994, p.81) state that both the "procedural and conceptual aspects are equally important…….. Emphasis on any one in isolation will distort student learning in technology".

The students also become aware that there can be many forms of technological knowledge and that different community practices have their specialised disciplines, communication means and terminologies.

Case Study

The 'Happy Hens' business produces a range of ceramic hens, cross stitch kits and kitchen linen. It is located at Portobello, a small township located quite close to the entrance to the Otago Harbour in which are located the ports of Port Chalmers and the city of Dunedin. This area is world famous for its wildlife and many tourists visit to view in their natural state a variety of penguins, seals, sea lions and the Northern Royal albatross which is located in a protected breeding colony. Portobello also has a rich history and figured prominently in the early settlement of the nearby city of Dunedin in the mid 1800's when there was a

HAPPY HENS ™

considerable influx of emigrants due mainly to the discovery of gold in Central Otago and the influence of the Free Church of Scotland.

The founder (and still the current owner) of the 'Happy Hens' business is Yvonne Sutherland who explains that her 'passion for the social history of Otago' and her background as a high school art teacher were pivotal in the formation of her enterprise. In addition, her knowledge of the challenges facing the early Otago pioneers, particularly the women, along with her love of traditional hen breeds have also been profound influences. This combination of historical influences, current local tourism trends, artistic talent and passion are critical to this enterprise and reinforce strongly the previously discussed issues of technological literacy and knowledge along with the comfortable 'partnership' of the afore mentioned social factors and 'conceptual and procedural influences' (Jones, Carr and Mather, 1994, p.81).

The choice of the 'Happy Hens' business as a case study was made for two reasons. Firstly, it is a relatively small unique enterprise which clearly illustrates many of the key features and characteristics of the New Zealand Technology Curriculum. Secondly it is deeply embedded in its social and physical environment. The location of 'Happy Hens' is very important to Yvonne Sutherland, who is adamant that she couldn't see her business being anywhere other than at Portobello.

'Happy Hens' and the New Zealand Technology Curriculum

One very important aspect that our students recognise is that the curriculum strands and achievement objectives need to be treated holistically and not fragmented into individual components. As Jones, Carr and Mather (1994, p.80) wrote when the New Zealand Technology Curriculum was being written,

> *"Technology education emphasises a holistic approach. Individual achievement aims are not discrete entities to be taught separately, therefore cannot be assessed separately."*

Other writers have also reinforced the importance of a holistic approach to technology. Seeman (2003) speaks of how having a holistic appreciation of technology is 'also becoming a vocational attribute expected of employees' and Grover, Mitchell and Fuller (2003) regard a holistic approach to technology as being 'the ideal in terms of pupils engaging with designing and making'.

Within this holistic approach we are able to use the real life community examples to draw attention to the detail of the curriculum strands and objectives. The New Zealand Technology Curriculum is centred on three *strands* which are **Strand A**: Technological Knowledge and Understanding, **Strand B**: Technological Capability and **Strand C**: Technology and Society. Within these strands are located the achievement objectives which are designed to intertwine in a variety of 'relationships' depending on the particular demands of different technological 'situations'. For example, achievement objective five in Strand B (Technological Capability) is about 'identifying needs and opportunities to provide information for possible technological practice'. This feature is essential in the establishment of any successful business and "Happy Hens' is no exception.

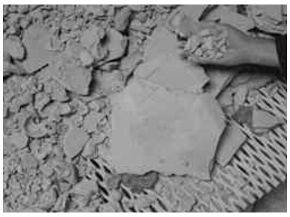
Linked strongly to this objective is the influence of the location of the business. The fact that it is on a major tourist route with a wide range of natural attractions was a key factor in identifying a possible enterprise opportunity. This relates quite naturally to objectives seven and eight in Strand C (Technology and Society) which concern people's beliefs, values, attitudes and culture. It can also include a consideration of past influences on current technological practice. Yvonne Sutherland's love of local history along with her knowledge of the role and challenges facing the pioneering women of Otago also had a strong influence on her decision to begin her business.

She also maintains enough flexibility in her production schedule to capitalise on special locally occurring events. Some examples here would be her 'limited edition' range of hens to celebrate the new millennium, All Black / England rugby football test matches and the Chinese New Year. This latter point is currently very significant with 2005 being 'the year of the rooster'.

These opportunities relate easily to achievement objective 6a in Strand B (Technological Capability) which pertains to the generation of 'possible options and strategies' as well as the adaptation and selection of solutions'. Then of course there are the obvious links to the achievement objectives in Strand A (Technological Knowledge and Understanding). For example, there are knowledge areas regarding the storage,

preparation, working and finishing the ceramic material used to form the hens, knowledge of specific terminologies (e.g. slip casting, fettling, blunger and deflocculant), the knowledge and application of production principles like quality control and aesthetics, health and safety issues and the application of systems of production, presentation, promotion and distribution.

It also becomes strongly evident that while the actual 'making' of the hens and other products relates clearly to Strand B, there has to be a continual engagement of a number of the objectives of Strands A and C. It is this constant 'flow' and interconnectedness between the strands and their achievement objectives that illustrates so clearly the holistic nature of technological practice. The utilisation of community enterprise operations like 'Happy Hens' has enabled our students to easily understand this very important feature of curriculum interpretation. This 'holistic appreciation' is also reflected in their subsequent technology planning for teaching and assessment.



Other curriculum aspects illustrated through investigating 'Happy Hens' could be in considering some of the technological areas (TINZC, p.12) that would be applicable here. For example, there are obvious links to Materials technology through learning about the types of ceramic material used to produce the hens or in the soft materials used in the cross stitch kits or linen ware.

Information and Communication technologies are evident through how the business is explained and promoted through brochures and the 'Happy Hens' web site. http://www.happyhens.co.nz/

Production aspects are encapsulated in Production and Process technology where both facets are clearly illustrated. A number of the Characteristics of Learning in Technology (TINZC, p.16) are also represented through this business. Examples could be the place of knowledge and skills in technology, the challenge of divergent options and multiple solutions, the attitudes of innovation and risk taking, the worth of failure analysis and cooperative work practices.

Conclusion

To conclude this paper it seems appropriate to quote from the Technology in the New Zealand Curriculum (1995, p.17) document…

> *"Exploring technology in the community, whether in the environment, in products, or in systems (…) gives students an appreciation of the relationship between technology and society, how decisions are made, and future opportunities for technological development."*

and finally from some of our students …

> *"It really weaves the strands together conceptually into a clear picture."*

> *"My visit helped me to put the Technology Curriculum into a very real context."*

> *"Opens the mind and makes it (the curriculum) personal and enjoyable."*

> *"It put the document into a context outside the classroom."*

> *"Utilising community resources has helped to make the holistic view of technology crystal clear."*

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'Happy Hens' website: www.happyhens.co.nz/

Technological Education Teacher Training Through the Planning, Teaching and Reflecting of a Pedagogic Unit

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Abstract

This paper describes a teacher training experience that took place in Santiago, Chile, with in-service teachers with no previous formal training on the subject. The paper is divided into three parts. The first part, briefly introduces the technology education teachers scenario. The second part, describes the experience of the training itself. The third, proposes an in-service teacher training model.

1 Technology education Teaching Scenario

Technology Education teachers in Chile have an enormous need of support for their teaching. Technology education was not a subject when they where at school as students, and it was not part of their teachers degree program. At the moment, as teaching support material, they have a mandatory National curriculum that state general Objectives and minimum contents to teach, and optional syllabuses for each given grade with activities to do with the students, both done with in the Ministry of Education. They do not count with other teaching material nor with procedures for student assessment. Conceptually, technology education is as new for them as for their students.

A pilot experience of teacher training was conducted by F. Elton with a fourth grade class during the second term of 2004. This experience aimed to pilot a training model that could help in-service technology education teachers in their manifested needs.[1] Aspects that teachers have highlighted as needs to enhance their performance when teaching technology education are:

- Awareness and comprehension of what the students should learn.
- Understanding of how the students progress in the main contents of the subject.
- Comprehension of how students learn concepts, abilities and understandings with in technology education.
- Knowledge about how to teach technology education.
- Knowledge on what to look for when assessing student performance and how to report back to students and to the teaching plan.
- Knowledge on management and planning to move the class to rich the learning objectives with in the subject.

The excellent reports of these experiences led Universidad de Concepción to get a grant from Fundación Andes, to pilot this training model with a larger group. Started in April, the University is working it with 40 teachers (from 4th to 6th grades) and 1.600 students from seven schools under the same administration (Fundación Belén Educa).

2 The experience: Teaching a Packaging Unit

The training was implemented in a school, in a poor area of Santiago. This school was picked because of its interest in lifting the students learning experiences on the subject. The teacher, a fourth grade general teacher, was selected because of her personal interest on the subject. The students of her class where 20 boys and 20 girls of an average age of 10. They came from a low social economic level, with parents with an average of nine years of schooling. The mentor was the coordinator of the technology education department in the school. The mentor had little previous training on the subject, as for the teacher had none. The experience was developed during the second school semester. The Unit worked “Packaging and publicity” was proposed in the syllabus done by the Ministry of Education.

2.1 Working process

Teachers that are actually implementing the subject in schools, are primary general teachers or specialize ones on another subject. As consequences of this, the value that teachers give to technology education varies, as well as the aspects that are emphasized when teaching it.

Taking into account these factors, the training activities designed for this experience, looked for opportunities to reflect with the teacher over the focus and nature of the subject, the learning’s that should be foster on students and how to go about when teaching it. This reflection *was done over the concrete task that the teacher was carrying out in her class*, considering factors raised from the nature of the subject contents, and restrictions from the social and economic conditions of the school and the students. This was determinative over the success of the experience and its recognition not just by the teacher and mentor involved in it, but also by the administration and the other teachers from the school.

Initiatives were taken to maintain the tension of the program and the teacher interest during the whole time that lasted the experience. The most valued initiatives for this were:having the help of a mentor in the school, counting with photograph registration of the teacher and the students class work activities, and establishing weekly meetings between the trainer, the teacher and the mentor to work on the following:

- Reading and analyzing the learnings and activities proposed on the syllabus
- Planning the lesson.
- Analyzing the students work performance
- Analyzing and upgrading the effectiveness of the lesson and the materials used, through the teacher’s perceptions and the evidence collected from the students work.

Below are described the tasks described above, taking as example the work done for the lesson N°1 of the packaging unit:

Reading and analyzing the learnings and activities proposed on the syllabus

This activity gave the trainer the opportunity to work with the teacher and mentor over their comprehension about the focus of the subject and their awareness and comprehension of the learning's to be worked with students. During the planning, time was engaged on discussions about what it is valued with in technology education, specifically with in the contents to be worked. It became more frequently teachers remarks about social and environmental issues behind technology and the need of fostering on students attitudes for 'active participation', 'responsibility as users', 'collaborative work', 'innovation' 'creativity' and so on. A good indicator that a shift in the teacher's comprehension of the subject was taking place.

The first activity done with the teacher and the mentor was to go over the syllabus, analyzing the Units contents and aims of the learning. The result was an adjusted version of the Unit objectives and students learning's, making them more plausible to their reality. The previous teaching of this unit in the school, had been done with a strong emphasis on handcraft activities, so appreciation of the changes that took place on the teachers and mentors perception of the subject could be gauged.

Planning the lesson

There are many interpretations of the syllabus depending on the background teaching experience of the teachers. The same happens with the didactics. Teachers have the tendency to teach technology education in the same way that they used to teach the other subject. When added these two things, technology education succumbs into the own teachers paradigm of what the subject contents and teaching ought to be.

This is why in this training experience was so important to have time to work the comprehension of how students learn concepts, abilities and understandings with in technology education, and how to plan and manage activities to move the class forward in reaching the learning objectives.

Working with the teacher over the Packaging Unit was a special challenge for the trainer. It had many contents associated with attitudes as consumers and producers of technology, what it could have made it less interested for a teacher and students that were expecting handcraft activities. Fortunately, this did not happen.

Since each lesson had more than one session, it was not necessary to plan each week. The weekly analysis of the

Teachers rewrite version

Unit: Packaging and publicity

A key dimension for an appropriate use and consumption of products, is the use of information available plus the attitude of consumers. In this semester students learn about the information from products that comes on packages and publicity, developing capacities for critical analysis of this information. Students get to know properties and functions of packages, developing observation, innovation and creativity skills. Students also learn about Sernac (Government institution that guarantee consumers rights) work and work on developing responsible attitudes as users and consumers of products.

Learning aims.

The students:

Read the information from the package before consuming the product.

- Distinguishes among functional, advertising and informative elements of a package.
- Distinguishes information from a package that refers to the characteristics of the product from another that refers to its use or consumption.
- Identifies missing information of the product that it is important for the consumer.

Manage information related with their consumer rights.

- Identifies Sernac as the government organism in charge of looking after the consumers rights and duties.
- Understands the right of being informed in opportune and truthful way.
- Understands that as consumer they have the duty of being informed on the product.

Evaluate and design or innovate packages for products that are familiar

- Identifies aspects of a package meant to protect the product. Show a personal opinion of how effective they are. Produces ideas to innovate on them.
- Identifies aspects of a package meant to contain the product. Show personal opinion of how effective they are. Produces ideas to innovate on them.
- Identifies aspects of a package meant to promote the product. Show personal opinion of how effective they are. Produces ideas to innovate on them.

Lesson N°1: "What do packages and labels tell us about the product"

Session 1 and 2 – 180 minutes (2 weeks)

Challenge: Students learn that a misinformed consumption of products can be bad for their health. That they have the right of being informed in a opportune and truthful way, as well as the responsibility of getting information as users and consumers.

Session 1

Act. 1 Introduction. All the class with their parents.
The parents are invited to an extraordinary meeting to listen, together with their pupils about the introduction to the semester in technology education. They watch a slide show used to motivate the class on the topic being work. Then, parents and students are invited to comment the work sheet N'1 previously read at home as a homework task.

Act. 2 All the class.
The teacher invites the students to say what they know about the topic and register the information. The students observe news related with impacts in the population's health for the misinformed consumption of harmful products. They analyze the consumer's rights. The teacher presents them a material in power point to facilitate this activity.

Session 2

Act. 1 Groups of three
The students analyze the information from packages or labels from different products of different type: Food; Medicine; Clothing; Cleaning products. With the information they extract from them, they complete the work sheet N° 2. They Make a list of symbols and specialized vocabulary that are in the products and search information about their meaning. They register this information in their notebook.

Act. 2 Groups of three
They work on the evaluation activity from the work sheet N°2. A representative of each group exposes to the class the result of this.

Closing

The teacher registers this information on the blackboard, and based on this, emphasizes the rights of being informed in opportune and truthful form, and the responsibility like consumer of being informed.

Didactic material for the lesson

Motivational slide show for parents and students. Slide projector.
Power point about actualized news about consumption of harmful products. Data projector.

Students materials

Clothes with labels on, medicine, food and cleaning packages (with out the product in case of medicine).

effectiveness of the previous session and the materials used were important though. Also, every week it was necessary to work on the elaboration of materials for the next session.

Above is outlined the plan developed for teaching the lesson N° 1. The work was based on the syllabus elaborated by the Minister of Education, although the teacher and mentor did the necessary changes to make it plausible.

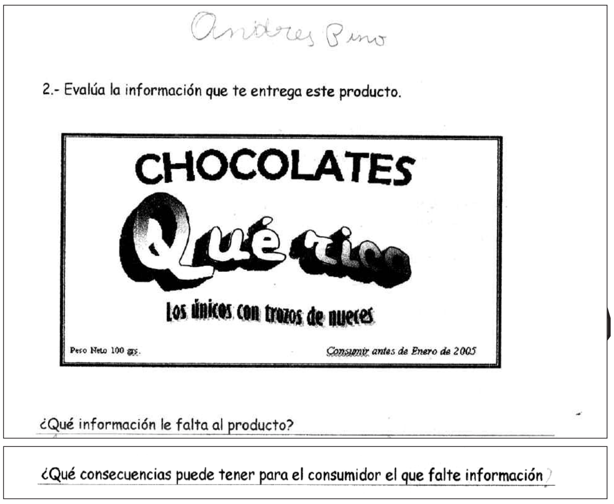
In the appendix are enumerated the sequences of the lessons that the teacher planed for the Unit. Through reading the activities listed and comments written by the students in their books, it can be appreciate that the focus the teacher gave to the Unit, it is in the track of what technology education aims at.

Analyzing the students work performance.

This work was very effective in helping the teacher visualizing the learning's, what to look for when assessing the student work performance and, how to report back to students and to the teaching plan. In designing the evaluation process, the discussion was centered on clarifying which learning's where going to be evaluated, the work that students should do, and on the indicators to be use to asses the work.

An example of this can be appreciated (over) with the work done over the same first lesson.

- In the context of its answer, uses in appropriate way the concepts of: pack, product, service to the consumer, information for the consumer.


2.- Evalúa la información que te entrega este producto.

CHOCOLATES

Qué rico

Los únicos con trozos de nueces

Peso Neto 100 grs.

Consumir antes de Enero de 2005

¿Qué información le falta al producto?

¿Qué consecuencias puede tener para el consumidor el que falte información

Figure 1 shows the evaluation activity children had to complete. (the type writing are the comments made by the teacher looking to enhance the item after going through the students work performance).

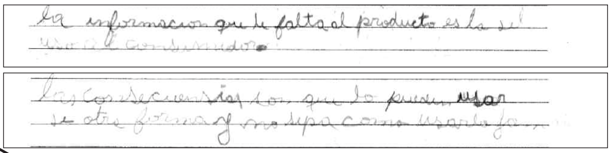
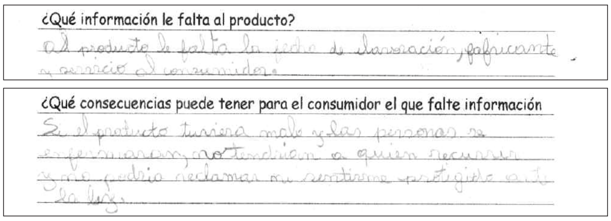
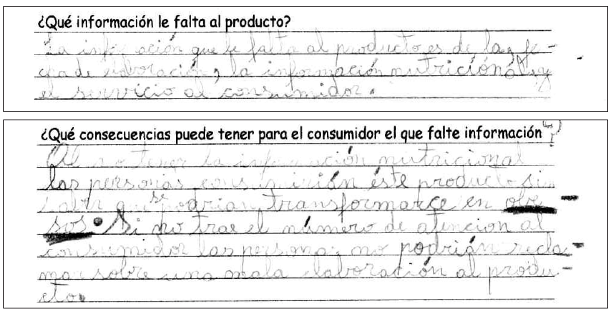


Figure 2: Work example of a low performance


¿Qué información le falta al producto?

¿Qué consecuencias puede tener para el consumidor el que falte información

Figure 3: Work example from a good performance:


¿Qué información le falta al producto?

¿Qué consecuencias puede tener para el consumidor el que falte información

Figure 4: Work example from a very good performance

Figure 2 , 3 and 4 show the students' worked over the evaluation activity of the work sheet N°2 . The work was evaluated using the following indicators:

- *In the context of its answer, uses in appropriate way the concepts of: pack, product, service to customer, information for the consumer.*
- *Identifies in the label the following information: elaboration date, weight or quantity, ingredients, maker, service to the consumer.*
- *Identifies in the label missing information in anyone of the categories previously mentioned and possible consequences for the consumer.*

Analyzing the effectiveness of the lesson and the materials in based of the teacher's perceptions and the evidence collected from the students work.

This work was done at the end of each lesson. The trainer worked with the teacher and mentor over the comprehension of how students learn concepts, abilities and understandings within technology education.

Both, the teacher and the mentor were actively involved in this activity. It was an opportunity for the teacher to express what she thought of the work done, the good and the bad, and look for assistance when needed. For the mentor it was very interesting learning what was possible and what was not, since he had to coordinate the work of other teachers in technology education.

Some remarks that the teacher made after the first two sessions:

> *"Parents were very interested on this topic. Most of them have one bad experience as consumers to share and they ask for information about Sernac. It will be a good idea to bring to this meeting the representative from Sernac instead of later in the year as planned"; "The slide show has to be with examples of products of kids familiarity"; "For the discussion of the first session it is better to have prepared a good set of questions as to guide the conversation. Other wise parents can take over the conversation or can be produce long batches where no body talks"; "The work with sheet N°1 also work skills of reading, comprehension and vocabulary enrichment, so it can be used as a language exercise as well"; "It is necessary to read with the students the instructions for sheet N° 2 before starting the work, because not all children in the class have the same comprehension reading skills as to follow the instructions"; "Putting in front of the class the technical symbols and vocabulary that children encounter in labels with their meaning works better with children that are left behind"; "When kids come with a concept as "dry cleaning" , where they have a misconception of the process, it is a good opportunity to show it to them. They loved it".*

3 A technology education in service teacher training model for Chile

The model at issue privileges the construction of knowledge on the basis of the teaching practice of teachers, by reflecting on the subject contents, the classroom experience and the evidence of the students' work. It is also based on the accompaniment of teachers by academics, bringing together the advantage of both, two worlds that usually are disconnected-university and school. During the course, leadership capacities are worked in the school through mentors, assuring the continuity of technology education without external support. The novelty of this model over teacher training that commonly takes place in Chile, is that normally they are disconnected from teachers' class performance.

Training Structure

The training is structured so that the reflection on the practice serves as a platform to learn about Curriculum, Didactics and Evaluation. The working dynamics that it is used for the learning in each one of these areas has three components:

- Knowledge acquisition on the subject (concepts, abilities and attitudes) and on the teaching of the subject
- Reflection of the teaching practice on the basis of evidence from the classroom work (how it is learned, is taught and assess in technology education), and
- Teaching hours

The working instances are:

1 Training sessions
Technology education trainers and mentors, work with teachers. Contents are worked on bases of the reflection over the teaching practice. These are:
– echnology education curriculum instruments analysis
– Technology Education contents learning: Project development; Technological system analysis; Technology and society
– Analysis of technology education teaching process based on classroom work evidence
– Lesson planning
– Students work analysis

2 Planning sessions
Teachers work collaboratively with the assistance of mentors. Activities are:
– Didactic material development for the lessons
– Students assessment material development

3 Teaching
Teacher teach technology education. Mentor assist to the classes as observer, and register by photos students and teachers work. Later, this material is used in the training and planning sessions.

Web site

The training is reinforced by a web site. The purpose of this site is to give teachers access to successful teaching experiences and teaching materials. These materials can be used for teaching as for training purposes. The site is structured as follow:

- School levels: it contains curricular documents as the Curriculum Frame Work and Syllabus.
- Lesson's plans: modules with activities for teachers and students, didactic materials, bibliography, assessment.
- Assessment: materials, students work examples; analysis of students work.
- Didactic material: presentations; activities; literature; Internet directions; bibliography, etc.
- Investigations: Students' thesis work, and other papers related to the subject area.
- Teacher contacts

Conclusion

Most of the in-service teacher training that has been delivered within technology education, has been done by teaching them contents and didactics disassociated from their practice. This has had little or no impact in improving the teaching and learning of technology education.

The training experience described above was innovative in the delivery model used, privileging the construction of knowledge on the basis of the teaching practice by: reflecting over the subject contents, the classroom experience and the evidence of the students work; by the accompaniment of the teacher by the trainer and the mentor; and by installing capacities on the mentor as to pursue on the implementation of the technology education in the school.

In spite of the successful results obtained through the experience, it cannot be concluded that the model used will work with a larger population. If the results of the experience being at the moment carried out by the University of Concepción in the training of 40 teachers in the same form, is successful, we could infer that the model works. The challenge then, will be to incorporate the TICS in delivering to more teachers.

Notes

[1]
- Comprehension about the focus of the subject.
- Awareness and comprehension of what the students should learn.
- Understanding of how the students progress in the main contents of the subject.
- Comprehension of how students learn concepts, abilities and understandings with in technology education.
- Knowledge about how to teach technology education.
- Knowledge on what to look for when assessing student performance and how to report back to students and to the teaching plan.
- Knowledge on management and planning to move the class to rich the learning objectives with in the subject.

And About Pro EdaDe?

PUC PR – Pontifícia Universidade Católica do Paraná. UFPR – Universidade Federal do Paraná.
CEFET PR – Centro Federal de Educação Tecnológica do Paraná Curitiba / PR / Brazil
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Abstract

The main objective of this paper is to present the activities and projects developed by the Pró-Edade program. The Pró-EdaDe program (originally conceived during the author's doctorate studies) became a small Centre that works in Curitiba (Brazil). It seeks to promote researche in the field of children's education through design and to develop didactic materials to help teachers and students of Brazilian Primary School (particularly in Curitiba and Florianópolis).

Among the activities that will be shown in this paper are the research project that is being developed by the Centre, sponsored by Araucaria Foundation; the undergraduate work advised and directed by the lecturers of the Centre, and the construction of a virtual classroom in Eureka Virtual Learning Environment, to support researchers, teachers and students interested in EdaDe – Education through Design.

Some history

The EdaDe is an abbreviation of the Portuguese expression 'Educação através do Design' [Education through Design]. It is a pedagogic proposal that initiates the children's education by design tasks. It is the result of a Doctorate Thesis developed by the author of this paper, tutored by Alice Theresinha Cybis Pareira, PhD, in the Postgraduate Program of Production Engineer of UFSC – Federal University of Santa Catarina. It can seem strange that an Educational Thesis (particularly about children's education) was developed in an Engineering Postgraduate Programme but in this programme there was a research aspect called 'Integrated Design Management'. Some issues including 'Design and Culture' were researched. The thesis investigated design, culture, education and their pedagogic relations. The study was focused on infant education; in other words, in the basis of the educational system. Besides the benefits generated by D&T in every person's education, we believe that design activities in primary school can help to renovate and consolidate a strong design culture in our society. Investigations were undertaken relating to how children learn and how design activities could help the children's progression in school. Some models and educational proposals were studied, including English D&T, and American Technology Education, among others around the world.

The main objective of the Thesis was to look for an alternative and appropriate way to teach and learn by design tasks, during the child's school life.

Brazil has its own way to promote infant education – an organized system, educational laws, curriculum parameters, etc. – certainly, modern and updated but, there are not subjects such as Design Education, D&T or Technology Education in its official curriculum and, from our point of view, this is a great omission. Commonly Technology issues are superficially offered in Science subjects as well as Design assignments in Arts.

The Thesis identified the values and the importance of the D&T assignments for children's education and among the recommendations outlined in the document, was the framework to put into practice the ProEdaDe programme. The programme seeks to promote the inclusion of EdaDe, in a complementary way, into Brazilian primary schools.

The ProEdaDe program

After the Doctorate activities were concluded in 2002 the ProEdaDe program was rethought, analysed and reorganized and then it was presented as a research project to the Araucaria Foundation in 2004.

The Araucaria Foundation is a private organization of public interest, devoted to support research projects, and human resource training needed for the State of Paraná scientific and technological development. Araucaria Foundation started its activities in January, 2000.

The main objective of the project is to develop a complementary programme of EdaDe and to apply it experimentally, in some primary schools of Curitiba Among its specific objectives are:

- To create and develop design tasks (DMAs – Design and Make Assignments) appropriate for the initials stages of our primary schools;
- To develop other didactic resources to support the EdaDe tasks in the classroom;
- To instruct and aid the primary teachers in the use of resources and to apply the tasks;
- To apply the tasks and the resources with an experimental group of children;
- To promote the collaborative and inter-institutional work;
- To guide undergraduates and to promote their initiation in scientific research field;
- To publish its results and to promote the EdaDe in the schools' communities;
- To continue the work begun during the author's doctorate
- To establish an infra-structure for the research in Curitiba, and to promote the involvement of higher education institutions, students and researchers.

A small but lively Centre

The research project was approved and received some financial resources from the Araucaria Foundation. The ProEdaDe program became a small Centre located at the 8th floor of Dom Pedro I Building at UFPR's Central Campus in Curitiba. It works in an office room and offers some facilities as telephone, computer,

Figure 1 – D. Pedro I Building, UFPR Central Campus

Figure 2 – The 8th floor, Design School Hall

Figure 3 – EdaDe office

Figure 4 – EdaDe office

printer, scanner, internet connection, library access, photographic and video equipments, a small bibliographical collection and some others didactic resources. In addition, there are other facilities available at the School of Design. In spite of being based at UFPR, the Centre still has important physical support from PUC-PR – Pontifical Catholic University of Paraná. Classrooms and laboratories from the School of Design of that Institution, its copy service and its virtual learning environment called Eureka may be used.

Now the staff of the Centre consist of two researchers (one from UFPR and other from PUC-PR), two grant holders financed by the Araucaria Foundation (one of each University) and some volunteer collaborators from both Universities and other institutions.

It is important to remember that the Centre does not have any money making purposes. Its members receive wages as employees of their Universities or grants from the supported research projects; actually, the time dedicated to the Centre is not remunerated. The Centre survives with the support of Design Schools, with some financial resources obtained from the research projects and with the voluntary work of some students.

The Center's activities

Obviously, now the main activity developed by the Centre is the research project financed by the Araucaria Foundation. The project began in April 2004 and it will be concluded in the middle of the second term of 2005.

Among the aspects that will be undertaken is the conception of design and make assignments. We researched and studied several DMAs in the available research sources (books, internet, manuals, workbooks, etc.). We selected those tasks that seemed more appropriate for the child. We tried the chosen tasks and adapted them. But, during our studies and researches we were able to conclude that teachers just teach what he or she knows very well. Certainly, they must be very confident and conscious to adopt the EdaDe in their classrooms. We did not have doubts about the children's interest in EdaDe; however, we were more and more convinced: 'teachers are the keys for EdaDe' and then, we redirected the project and began to work with, and for, them.

We designed a workshop to show and to train the teachers. We already had tried something similar in Florianópolis a year ago (also see Pereira's paper in these conference proceedings). The workshop was divided in four parts. The first one was called 'Understanding Design'. In this section we argued about design, its basics and history and about methodologies adopted by designers to solve problems and concept products. We have elaborated some printable papers about these themes; a power-point presentation (an OHP alternative) and some short tasks to be done in the classroom.

The second section was called 'Understanding EdaDe'. It is about EdaDe basics, pedagogy bases of design tasks and about different kinds of EdaDe activities. The third section was called 'Developing Design and Making Skills'. In this section the tools, equipments, materials and techniques are shown in order that models and prototypes could be made. The fourth section was called 'Practising EdaDe'. It is about how we can put into practice the EdaDe in the classroom. Some printable papers and power-point and OHP presentations are used. The sections are accompanied by several short tasks, and each one lasts four hours. They are offered in the dependences of the School of Design of PUC-PR but it is possible to offer in-service sections – This is not still on-going. We think that the workshops by themselves are not enough but certainly it will help to promote EdaDe in the school community.

We are creating a booklet for teachers and another for children about EdaDe and its activities. It is destined for the teachers and pupils of the first four classes of our Primary School. In these didactic resources are some recommendations and DMAs.

A book is being writing for children named 'Conversando com as crianças sobre design' [Talking to children about design]. We are trying to publish it with the partnership of entrepreneurs from the State of Paraná and support from the Cultural Foundation of Curitiba City. The book will be distributed without costs to the Primary Schools.

We are creating another workshop to be undertaken at the schools, with children. We hope to put it in practice as soon as possible. It is still in a conception phase.

Another initiative that is being realized by ProEdaDe programme refers to the use of a VLE – Virtual Learning Environment called Eureka, developed and maintained by PUC-PR. This VLE is a virtual complement for the physical classroom. We offer by the EdaDe Virtual Classroom: references, contents, web links, a mail, a forum and a chat.

Initially, the EdaDe Virtual Classroom has been used by the members of the Centre as a way to organize the research project and to serve as a place for discussion, sharing and reflection on this field; but we would like to use this virtual room to support the teaching and learning activities in the next workshops promoted by the Centre.

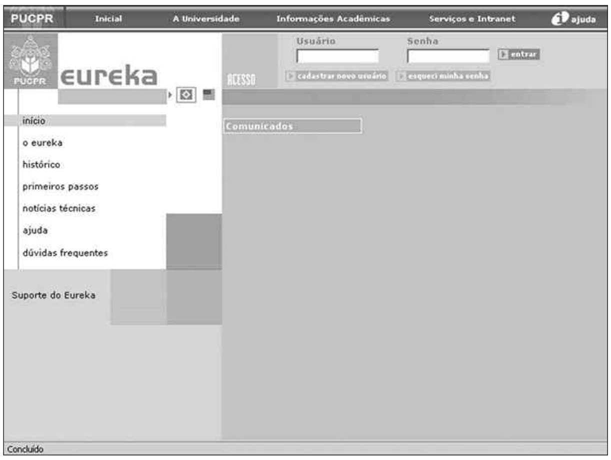

Figure 5 – Eureka Virtual Learning Environment, initial page

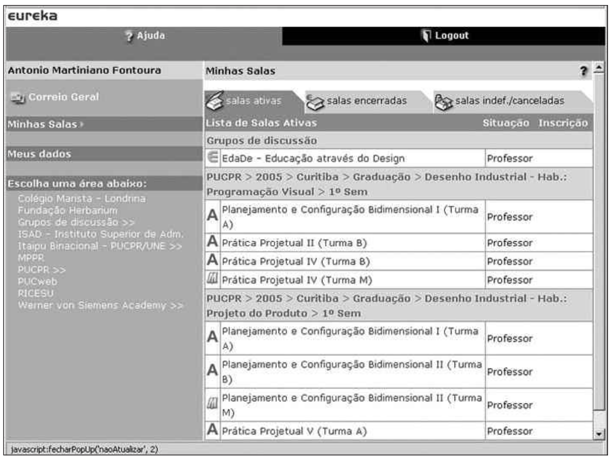

Figure 6 – Eureka Virtual Learning Environment, virtual classrooms

Figure 7 – EdaDe Virtual Classroom, initial page

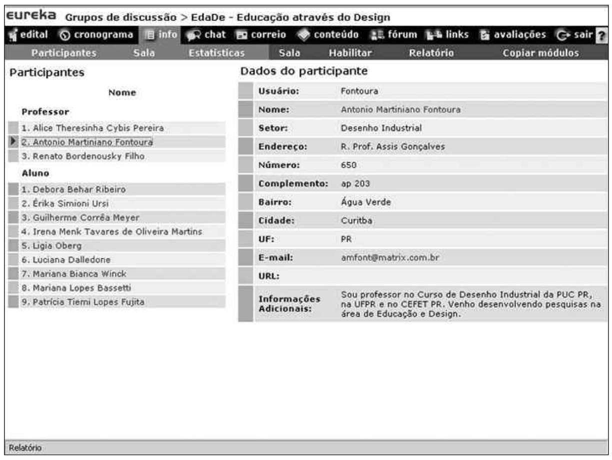

Figure 8 – EdaDe Virtual Classroom, information page

We are writing some articles about EdaDe for magazines (e.g. ABCDesign Magazine) and newspapers (e.g. O Estado do Paraná) and some papers for conferences (e.g. P&D Design 2004). Beside those, we are offering some lectures in academic meetings (e.g. Semana de Pesquisa e Extensão do DeDesign UFPR 2004 and Semana de Design do CEFET 2005).

During these last two years, we were co-advising a Master dissertation and we were, and are still, advising on undergraduates' work about EdaDe or related to it in UFSC, UFPR and CEFET-PR – Federal Centre of Technological Education of Paraná. We also participated, as appraiser, of several masters degree works in UFSC.

To Conclude

Some time ago, the ProEdaDe was just a dream, an idea, a project, a blueprint. Little by little it is transforming into reality. Now we have a small but active and very focused Centre to promote EdaDe in Curitiba. We are planning the Centre's future and we would like to maintain agreements and contacts with other Institutions and Centres with the same interests around the world. Another intention of the Centre, through its actions and merits, is to become a reference point in the Brazilian Design Education field.

Without the support of PUC- PR and UFPR Design Schools, the good will of some people and the initial financial support from Araucaria Foundation, the Centre and its initiatives would be unviable. As already said, the Centre does not seek profits. It works on behalf of education and to promote education through design. It is still a modest place to ferment and to cultivate the research spirit but we are looking ahead. We want to place in action all the activities described in this paper and to conclude, in the best possible way, the ones already initiated.

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  (design student / collaborator – PUCPR)
- Débora Behar Ribeiro
  (design student / collaborator – CEFET PR)

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Packaging-a Case Study with Y6 Children (aged 10-11 years)

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Abstract

The case study focuses on a project that children aged 10-11 years have undertaken in a primary school in Wales. Whilst there are similarities, Wales has its own curriculum, and there are differences between Wales and England. However the integration of the use of Information and Communication Technology (ICT) within design and technology is important in both countries. In this case study – the use of ICT through a program – Primary Design is highlighted and it is shown how it was integrated into learning and teaching.

The children in Year 6 were asked to use Primary Design, to design and make a package. The package had to hold a new hair gel product or a chocolate product in safely and securely. The children were asked to consider their targeted audience, persuading them to buy it.

Introduction

Clytha Primary School is situated in the heart of Newport City Centre, South Wales. There are single year intakes from Reception to Year with 196 children currently on roll, 27% English as an additional language (EAL) and 18% special educational needs (SEN). From June 2005 there will also be a nursery. There are eight teaching staff and ten NNEB's and classroom assistants to support SEN children.

Clytha has 15 computers in a suite and 3 computers in each of the 7 classrooms. Three classes have a fixed interactive SMART board.

The school is well resourced in design and technology (D&T) with all resources stored centrally. In the main, D&T is delivered in block sessions. A mixture of Qualifications and Curriculum Authority (QCA), ACCAC (the Welsh equivalent of QCA) and Newport Local Education Authority (LEA) materials are used. My role of Design and Technology subject leader involves writing a policy, monitoring planning, ensuring the continuity and progression of knowledge, skills and understanding and supporting staff in the development of their own skills. Work is levelled alongside teachers in order to identify targets for improvement to move the child forward.

Due to the progression of skills throughout the school, Year 6 have a secure understanding of design and make process and were developing into independent learners. ICT is a tool that can be used to enhance children's learning and inspire their thinking and creative skills, so the QCA 3A unit 'Packaging' was adapted. I wanted to develop the use of Computer Aided Design (CAD) in the school and purchased the Primary Design software. Currently, the children in Year 3 design and make packages to hold Easter eggs securely, so I was able to build on previous learning experiences and skills. By using CAD to design packaging, my aim was to develop the children's ability to design for particular users and purposes and to think about how to persuade audiences to purchase their product. The children were asked to consider shape, colour, fonts, logos and images to enhance the final appearance of their product. The children were also participating in a Young Enterprise scheme, called 'Dynamo', which was an initiative by ACCAC and the WDA, where they had to design and make their own product and then sell it to an audience. I used the Packaging project to teach the children the skills and knowledge needed for successful packaging, so they would be able to make their own informed decisions during their Dynamo work.

A 'real' designer

To inspire and motivate the children for the Design and Technology project, a parent, who had his own product design company, was invited in to talk to the children. He was able to talk about the work involved in designing and marketing quality products that will attract the consumer's attention on a supermarket shelf. He was able to share his experiences of successful and failed products and what modifications were made as a result. He was aware that the children were setting up their own business through the young enterprise scheme and that they may need a package for the product, as well as the fact they were designing and making packages in D&T. Together we discussed how the two projects would work very well together and what knowledge, skills and understanding the children would need to develop from his visit. The children learnt about the importance of research and investigation to help design ideas and that the brand names can really carry the product. By bringing in a selection of water products, our product designer was able to show the children about the importance of packaging and how this can influence immediately what the consumer thinks of the product. He focused on the cheaper brands compared to quality expensive brands and focused the children's attention on consumer demand. The children were told about purpose and audience and how important this was to bear in mind when designing. Questions made the children think about the importance of this: Who are you designing for? Who is your target audience? How will you meet their expectations? This visit really inspired the children to become creative designers and they could see a real purpose in the skills they were being asked to develop. They became critical consumers through investigating existing products and evaluative designers.

Evaluating products

The next stage of the project allowed the children to evaluate existing products on the market. The children had been asked in the previous week to bring in examples of packaging. They were asked to consider the users and purposes of their product and to justify any answers. They disassembled various packages to explore how they were put together and what made strong structures. Questioning focussed the children's attention on: purpose, audience, appearance, materials used, colour, shapes, sizes, joining techniques, information displayed on the packaging and their opinions of how well the product meets its needs. The children were continually reminded to evaluate their work as it progressed and to learn from studying existing products to inspire their own design ideas. The children were encouraged to compare packages and asking questions as to why most packaging products were cuboids. They were asked to consider how they could use/adapt some of the products for their own work. The children disassembled the packages and used the digital camera to take a photograph of it, which was then annotated using ICT. The children were asked to focus on two different types of packaging and to note the similarities and differences between them.

Links to numeracy

By demonstrating how to make a simple net, the teacher was able to focus the children's attention on accuracy when measuring, marking out and cutting out the net for a quality finish. The importance and requirements of the flaps were highlighted to the children. Strengthening techniques were discussed along with other suggestions, such as cutting a section out from the package to create a window effect, so that the product could be seen. The children then explored and assembled nets of more complex 3D shapes, which could be possibilities for their final package. A Numeracy challenge was set for the children to find as many different ways to make a net a possible. The use of the construction kit, Clixi, supported the children with this activity.

Key skills were evident as the children were communicating with one another, solving problems, evaluating their work and suggesting improvements. Numeracy skills were a strong focus as the children studied: 2d and 3d shape, nets, measuring, length of flaps and surface area were developed throughout the activity. Some children were given the opportunity the use the Internet to search for other forms of packaging, which was used as part of their research. The children were then given time to design their own packaging, including dimensions, bearing in mind the knowledge gained from the earlier research. They had to keep the purpose and user of their product strongly in mind as they began their initial designs. The children were asked to work in partners in order to develop their communication and teamwork skills and to solve problems together. Near ability pairs were matched together and work differentiated. Some children were encouraged to make cubes or cuboids with support, whilst other children went on to design and make triangular or octagonal prisms. Once the children had produced an annotated sketch of their design intentions, they were given the opportunity to make a paper prototype of their design. The children were encouraged to add text and graphics to their net models, ensuring it met the purpose. This was evaluated, modifications made and then the children were able to use the net of their prototype to support them, when designing their package using the CAD software, Primary Design.

Applying ICT within D&T

Using the interactive SMART board with the whole class, the children were introduced to the tools and techniques that could be produced using Primary Design. Children were invited up to the board to demonstrate their ideas, before giving them the opportunity to trial the software to see what could be produced. After the trial period, the children worked together in their pairs to design and make their packaging. The learning and teaching of this particular project was blocked in the computer suite, in order to allow the children quality time to design and make a package to a high standard. Opportunities were given to allow the children to demonstrate their design ideas with others groups for feedback and targets for improvement. This helped keep children's focus on the learning outcomes and the task given. Through the self-evaluation focus, the children were supported to develop their skills to become reflective designers and thinkers that evaluated each step of the design process. By telling the children they were 'product designers', gave them more confidence to play the part and produce high quality work. They were independent when designing their final products using Primary Design as they were well prepared and the skills they required were secure. As a result, the children applied their knowledge; skills and understanding gained from focused practical tasks (FPT's) and Investigate, Disassemble Evaluate Activities (IDEA's) and were becoming independent learners. Due to the fine detail some children wanted on their designs, they had to copy and paste their nets into a word document. The final finish of the products was of a very high and professional standard. The children had included company names, logos, ingredients, barcodes, images, graphics and text. Some children even made links with Curriculum Cymreig and Fair Trade. Their nets were accurate and the careful placements of the flaps, allowed the product to be strongly assembled.

The end product

After cutting out and constructing their packaging, the children were given the opportunity to mount and display their own work in the classroom to celebrate their successes. They were encouraged to evaluate their own and others' work in a positive manner and to suggest next steps improvements. This allows the children to take responsibility for their own learning from start to finish and gives them ownership of their work. The children know that their work is valued and therefore boosts their self-esteem and confidence.

Reflections

The children successfully designed and made a package for a particular purpose and user, using a CAD package called Primary Design. The children thoroughly enjoyed the adapted QCA 3A unit 'Packaging'. They were able to design, make, print and evaluate their work to a much higher standard than if they were using pencil and paper. Using ICT gave them the opportunities to learn through trial and error and to take risks as designers, as they knew it could be easily modified. It encouraged the children to be creative, and to explore and challenge their own thinking, whilst helping them to become independent learners. The use of CAD challenged and pushed capable children, whilst supporting the lower ability child. Those children who have difficulties putting pen to paper, or those pupils who feel they 'can't draw' were still able to access and develop their Design and Technology skills and feel successful of their achievements. They were not apprehensive about using CAD, but instead were motivated, inspired and confident designers. The use of the interactive whiteboard in the classroom made the teaching of CAD to the whole class far easier than it would have been to explain and develop the skills to make nets using paper. It allowed the children to develop new skills quickly and then to apply these skills to their work. The children were confident users of technology and were able to take risks and further develop their own skills and share these with peers. Their concentration skills and determination to solve problems was sustained for longer periods of time. As a result, the children produced quality packaging that they were very proud of.

Conclusion

In conclusion, the use of ICT in D&T enhanced the learning and teaching of the activity, resulting in a more professional end product. The use of CAD software to produce a package increased the accuracy and quality of the end product. Learning was more effective and the children were more confident to experiment and take risks more readily than drawing a net directly on to paper. The use of CAD supported and challenged all abilities of children to design and make a quality package for a particular user and purpose. It helped the children generate, develop, communicate and evaluate their design ideas through motivating and inspiring the children's and teachers' learning.

This experience has highlighted the substantial impact that ICT can have on D&T and will have implications on the way Design and Technology is delivered at the school. There is a need for other classes to use CAD to enhance the learning and teaching of other subjects across the Curriculum as well as D&T. To ensure continuity and progression of the children's knowledge, skills and understanding, CAD could be used to achieve more complex nets, such as the body shell for a controllable vehicle. There are further opportunities for CAD to be used in other QCA units across the school, which will support the subject leader and the development of staff skills in their professional development.

Implications for future practice:

- To support Year 3 to use Primary Design when making their cube shaped packaging to hold their Easter eggs,
- To address planning, highlighting where Primary Design and ICT can be used to enhance learning and teaching
- Continuing professional development (CPD) to show staff the benefits of Primary Design and ICT and how it can raise standards and support teaching.

Control Technology in the Primary School

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Abstract

This case study is a reflection by one teacher who took part in a Department for Trade and Industry (DTI) funded project that was seeking to identify an appropriate model for Continuing Professional Development (CPD) for control technology. This is a difficult area in the primary school for a number of reasons, the main one being lack of teacher knowledge and understanding and teacher confidence. It is an area that should be covered, as it is part of the National Curriculum for Information and Communication Technology (ICT) and design and technology provides an excellent context for this work. The paper is written by the teacher, who through a series of questions, reflects on her past, present and possible future practice and the impact the project had on her. *Introduction by Prof. Clare Benson, UCE, Birmingham. Clare.benson@uce.ac.uk*

Sarah Lane was one of 20 teachers who took part in this project. Models of CPD had been analysed and key elements incorporated into the structure of the CPD to trial it as an effective model, particularly for a practical area of learning. The research is on going-impact needs to be assessed some time after the event; schools will be asked for their perceptions of impact again in summer 2005, so the impact on the school over a longer period of time can be gauged.

The key factors that had been identified as playing a major part in CPD in providing a positive impact on teachers, schools and ultimately the children were:

- 2 teachers to attend a course so that they could work together, share ideas, support each other on the day and then support each other back in school
- Teachers would use the equipment on their CPD day that they would use in school (different equipment can be off putting); they had to unpack it and set it up
- Plenty of time to' play' in between each new learning point
- A limited focus to what was covered
- Plan on the day what each pair would do on their return to school
- Identify how this would be achieved

From initial analysis of the data collected, this model appears to have contributed greatly to the fact that 90% of the schools are now working with control with confidence. Sarah's reflections mirror those of most teachers.

The questions

Q: What did you think about control before the course?
A: Before the course I had no experience of control technology. My previous school did not have any software or equipment for teaching control.

This course came at a time when we looking for ways to introduce control into our Design and Technology project on fairground rides. However, I did not feel confident in my ability to teach the objectives laid out in the planning.

Q: What do you think now?
A: I was surprised at how easy it was to learn how to use control technology. I now feel enthusiastic and confident about delivering lessons on control.

Q: What happened on the course?
A: The course took on board the fact that many teachers view control technology with some trepidation. Firstly, two members of staff attended from each school. This enabled us to discuss aspects of the training throughout the day, particularly how the aspects of control could be introduced and developed at our school. Secondly, we were issued with the equipment that we were to take back to school at the end of the day. This meant that we were actually practicing with our own stuff.
The day was planned well, starting with an introduction to control and where it fitted into the curriculum throughout each key stage. We moved onto working with 'Learn and Go', a very simple program that could be used in a variety of contexts from making a bulb light up in a simple circuit, through to programming motors and lights in a fairground model. With 'Learn and Go', a small box is used that can be mains powered or run by a 9 volt battery. The control box is programmed by attaching lights, buzzers or motors to connectors. The 'learn' button is pressed instructing the box to remember the instructions it is about to be given, then a button relating to each connector is pressed or released to turn on or off the respective item. At the end of the series of instructions the 'go' button is pressed which instructs the box to play back the series of instructions. The instructions continue to be repeated in a loop until the learn button is pressed again to give new instructions.
The ease of this piece of equipment gave us all the confidence to realise that even if we took control no further, this activity could be used by a whole range of children across both key stages.
Feeling confident, we moved on to computer control through the program Flowol.
Flowol comes with a group of mimics to start the user off. You can program the lights on a zebra crossing, traffic lights on a one-way bridge and the lights on a light house. Each mimic requires the programmer to develop their skills gradually as the mimic becomes more complicated, therefore, making the program more easily accessible as activities can be differentiated to meet the learning needs of each individual.

Q: How was it followed up?
A: The course was immediately followed up at school with a whole school inset, however we only had time to introduce the Learn and Go to the staff. They quickly picked it up and enjoyed making models with lights and motors.
A few weeks later this was introduced to the children in Year 4 who were working on electricity in their science work. One task was to make a clown whose nose lit up. As an extension activity the children were shown Learn and Go and were able to make his nose flash on and off.
Year 6 children were later introduced to Flowol and the mimic when a teacher from a local secondary school came in to teach a master class. He had chosen control and was pleased to find that we had recently installed the program.
The Learn and Go boxes were also introduced later in the summer term when Year 6 were working on their Design and Technology projects of fairground rides. Again as an extension activity, the boxes were used to introduce the children to controlling the motors on their rides. The kits were not widely used across the year group last year as we only had 3 in school, however as they proved to be such a success we were able to purchase a further 12 so that we are now using them in class lessons enabling the children to share one set between two.

Impact on you and the children

I now feel much more confident at planning and delivering projects involving control technology. In fact, contrary to my expectations, I now enjoy teaching this area and feel it has enhanced my lessons in Design and Technology. The course took on board the fact that for many teachers, control technology is an area of the curriculum they would rather avoid. Therefore, while learning was at a fast pace, there was plenty of opportunity to 'play' with the equipment as well as consolidate our understanding by discussing the programs with our 'partner' from school and the tutors on the course.

We were encouraged to introduce our class to the equipment as soon as possible on our return to school, in preparation for feeding back at a twilight session at the University of Central England a couple of months later.

I started by introducing the Learn and Go boxes. The children worked in groups to produce fairground designs and used the switchboxes to light up and turn parts of their ride. The fairground project is always popular. However, the Learn and Go boxes stimulated the children's interest even more, and added an extra dimension to their designs as they now had to plan how they were going to incorporate control technology.

The mimics were used in our ICT sessions and they encouraged the children to appreciate the importance of control in real-life contexts. I modelled controlling the lights on the zebra crossing to show the children how to generate a flow chart and then gave them a problem to solve using the light house mimic. The children worked with enormous enthusiasm and were genuinely excited when their flow chart met the criteria of the problem. More able pairs were soon setting their own problems to solve and were able to write about what they had done and how it worked.

Reflections on the course

The course changed my outlook on control technology and this was due, in no small part, to the factors built in to consolidate our learning, as well as the fact that back at school we had the resources and equipment to get us started straight away.

The follow up twilight session was another incentive for us to use the equipment with the children so that we could feed back to the rest of the group. It was very useful to hear how other teachers had introduced the programs to their children, as well as their colleagues through INSET sessions.

Future

Control technology is now being taught in years 4 to 6 in our junior school. As a school we are now much more confident in our use of the Learn and Go boxes and the program Flowol.

We are now in a position to begin to discuss as a school, the progression of skills being taught in each year group to ensure that children of all abilities are extended. We need to purchase more of the interfaces so that models can be controlled by whole classes rather than just small groups. These will mainly be used by year six so that they can control their fairground rides through a computer, incorporating motors and lights simultaneously, as well as synchronising several rides at the same time. To develop this further, we would like to introduce sensors so that the children must also consider the effects of an input, such as a magnetic switch which would only allow the motor to work if a door was shut on the ride, bringing in aspects of health and safety.

The Use of Design and Technology Curricula in the Arab Education Systems to Improve Students' Achievements in Applied and Scientific Fields

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Abstract

Several Arab Countries have introduced Design and Technology Curricula (DTC) in the recent years as a subject of study and learning in Basic and Secondary Education, according to the Framework of Action for Education for ALL (EFA), Dakar, April 2000. The Design and Technology Curricula had been seen as a vital tool to achieve EFA goals, in particular goals three and six relating to life skills, quality and gender equality in Basic Education. Many countries of the region are facing problems in relating education to life and sectors of economy. Competencies within DTC, especially in early years of education have positive impact on secondary students' orientations and achievements in applied and scientific fields.

Three Arab Countries: Bahrain, Jordan and Lebanon are applying three different forms (models) of Design and Technology Curricula in their education systems. These models are:
1 Design and Technology Curricula – Bahrain;
2 Pre-Vocational Curricula – Jordan; and
3 Technology Curricula – Lebanon.

These models of education and learning had faced many difficulties (during the early stages of implementation) in adapting the new curricula to needs of the education systems; availability of laboratories, equipment and materials within schools; and training of the educational personnel (curriculum specialists, principals, and teachers) on the applications of the curricula within the education system. The paper will highlight the lessons learned from applying the DTC in these countries and their impact on students' achievements and competencies in applied and scientific fields.

The shared experiences and the lessons learnt on these new models of learning will encourage other countries in the region to select the best practices for their education system reform, with objectives to link education to life and sustainable development. (UN Decade on Education for Sustainable Development, 2005 – 2014).

Design and Technology Curricula and EFA Framework for Action

What are the potential links between EFA and DTC? Are there ways of integrating DTC into EFA goals? Or, vice versa, would it be beneficial to integrate the EFA-goals when working with DTC? To what extent is this already done? In April 2000, the World Education Forum DTC was organized in Dakar, Senegal. At this Forum the "Framework for Action, Education for All : Meeting our Collective Commitments" was adopted. This Framework for Action reaffirmed the vision of the World Declaration on Education for All, which was adopted ten years earlier, in Jomtien, Thailand, 1990. There are six goals in the Framework for Action. These are listed below, some in full because the entire text is considered important for the paper discussions that will follow, some are cut short (where this does not influence the content for the purpose of this paper).

1 Expanding and improving comprehensive early childhood care and education;
2 Ensuring that by 2015 all children, particularly girls, children in difficult circumstances and those belonging to ethnic minorities, have access to and complete free and compulsory primary education of good quality;
3 Ensuring that the learning needs of all young people and adults are met through equitable access to appropriate learning and life skills programmes;
4 Achieving a 50 percent improvement in levels of adult literacy by 2015;
5 Eliminating gender disparities in primary and secondary education by 2005, and achieving gender equality in education by 2015; and
6 Improving every aspect of the quality of education, and ensuring their excellence so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills.

The third EFA goal is to make sure that the learning needs of all young people and adults are met through access to appropriate learning and life skills programmes. A great variety of programs for this target group – young people and adults – exist. Many are very good, but many also need improvement. Clearly, much of what is referred to as "life skills programmes" entail DTC, or at least the technological aspect of the acronym.

The sixth EFA goal is to improve every aspect of the quality of education. There has been a tendency to focus more on access to education than the quality of education in development cooperation projects, but this is changing. This was elaborated on in one of UNESCO's World Education Reports in the late 90's. While we must strive to provide education for a greater number of students, it is increasingly recognized that the content and methods in that education also must be such that students can learn once they find their way into schools/education/training. But we will always be seeking to improve that content and those methods because we live in an ever-changing world. In this search for both content and methods, it is wise to include expertise from various fields, such as DTC.

DTC Applications in the Arab States: Bahrain, Jordan and Lebanon

There are several applications for Design and Technology Curricula (DTC) in the Arab region. Most of these applications were developed during the last decade of the Twentieth Century (1991 – 2000). A short description of three models (experiences) in Bahrain, Jordan and Lebanon are the focus of this paper:

1 Design and Technology Curricula in Bahrain:

The Design and Technology Curricula in the Kingdom of Bahrain is part of developing the education system to meet challenges and requirements of the Twenty – First Century, with emphasis on making balance between theoretical and applied topics and fields within school curricula. Field experiences, practical applications and life skills are major parts of the new curricula. The curricula was introduced during the school year 1999/2000 as a joint project between the Ministry of Education in Bahrain, UNESCO and UNDP.

There are six fields within basic education curricula (grades one to six):
- The role of DTC in the daily life of students;
- Materials and tools;
- Technological systems;
- Energy;
- Consuming and evaluation;
- Computers.

The curricula is taught now in all basic education schools (more than 120 schools) for both boys and girls. The Ministry of Education is considering expanding the project to Intermediate Schools (grades 7-9) in order to link 13 practical fields taught in this cycle, within the Design and Technology Curricula (DTC).

2 Pre – Vocational Curricula in Jordan:

The Education Council in Jordan approved this Curricula in 1989 as part of the Education Reform Plan (ERP) for 1999 – 2000. The Curricula is taught in all basic education schools (10 years) as follows):
- Cycle one (grades 1 – 4): which covers four areas (health and nutrition, life skills, general safety and traffic awareness, and practical applications). Most of the knowledge and skills are related to hands on experiences and vary simple activities related to students' life.
- Cycle two (grades 5 – 7): this cycle include 17 units clustered into five vocational fields: Agriculture, Industry, Commerce, Home Economics, and Health and Safety. It is the Curriculum objectives in this cycle that all students acquire wide range of knowledge and skills related to life and economy in the society.
- Cycle three (grades 8 – 10): this cycle include 70 practical units within the same fields in cycle two. It is up to the school management to decide on the units/ fields applicable to the learning environment and community. Most schools will select two to three related fields to make it easier during selection of teachers and materials for the Curricula.

There are several individual and groups activities within the three cycles. It is assumed that the selected fields especially in higher classes are related to students' and schools' environment. Low cost materials are used within curricula to improve environmental protection. Innovations, critical thinking, and problem solving are major components of curriculum experiences (theoretical and practical).

3 Technology Curricula in Lebanon:

The Lebanese technology curricula is focusing on the following main goals:
- Students' interest and their technological needs;
- Stages of development and growth according to students' age;
- Linkages with other topics and fields within school curricula (i.e. mathematics and sciences); and
- Available local resources.

Each topic within the Curricula is project oriented and includes the following components:
- General information;
- Educational and learning materials;
- Conclusions and expectations;
- Observations and orientations; and
- Evaluation.

The Lebanese technology Curricula starts with grade four in basic education (9 years). It is technological orientations in several fields of economy related to society, such as:
- Food and agriculture;
- Electricity and magnetism;
- Mechanics;
- Other technologies; and
- Design and implementation.

For grades 7 – 9 of basic education, the projects include the following fields:
- Materials;
- Mechanics;
- Electricity and electronics;
- Chemistry and life.

The curricula is applied in private schools as part of the science and technology projects, while most public schools (more than 50% of schools) do not have the necessary place (labs)or qualified teachers for the subject. The Ministry of Education and Educational Centre for Research and Development (CRDP) has concluded an evaluation for the introduction of the school curricula initiated during 1996 – 1998, which include the Technology Curricula, Music and computers as practical fields within the Curricula. The results of the evaluation (Beirut, 2003) have highlighted the need for a more comprehensive approach at both the policy and programme levels to make such topics available for all schools (public and private).

Lessons Learned

Based on the shared experiences in Design and Technology Curricula applications in three Arab countries (Bahrain, Jordan and Lebanon), a set of lessons can be drawn on this topic for the expansion of such curricula in other countries in the region.

The EFA Global Monitoring Report: The Quality Imperative – 2005 (UNESCO HQ Paris) had indicated that the Arab region (22 countries in West Asia and North Africa) has made significant progress over the last decade in terms of school access and retention. Nonetheless, massive educational deprivation and large gender disparities still characterize some countries. Education quality poses a challenge: An enormous gap exits between numbers of pupils graduating from schools and those among them mastering a minimum set of cognitive skills. Yet, achieving education for all, which is essential to a wide range of individual and development goals, fundamentally depends upon the quality of education available. The Dakar Framework for Action (2000) recognizes that the two are inextricably linked and declares access to high quality education to be the right of every child.

Bahrain, Jordan and Lebanon have shown progress in achieving EFA goals 3, 4, and 6 compared to other countries in the region during 2000 – 2004, compared to 1990 figures, based on EFA Global Monitoring Report – 2005.

Indicators and tables on the Arab States will be part of the paper presentation, and available on the website: www.unesco.org/efaglobalmonitoring report2005.

The set of lessons learned that can be shared with CRIPT Conferences participants are:

1 The leading role for school principals in the early phases of projects initiation, especially in dealing with parents and availability of places (labs) for the practical applications. Involving the principals in the training programmes with teachers and curriculum specialists has resulted in a faster implementation (Bahrain and Jordan cases).
2 The evaluation results of DTC in Bahrain have indicated that through this curricula, the schools were able to make more connections with parents and the community in aspects of learning (not limited to DTC). In certain cases parents and business enterprises had donated materials and equipment to be used in the schools and the learning process.
3 Several countries in the Gulf area (i.e. Qatar, Oman and UAE) have indicated that DTC is more applicable to all students in basic education compared to the current approach of having life skills curricula for boys and family education for girls. (in most of the Gulf countries).
4 The Ministries of Education in most of the Arab Countries have taken initiatives (during the planning of new schools and buildings), that a multi – purpose room should be available within school structure to facilitate the DTC laboratory /workshop. This could apply also to computer and internet connections.
5 A teacher in Al – Muharak Educational District – Bahrain had used the DTC to mainstream a student with special learning needs. The teacher is using this case as part of his graduate studies at the University of Bahrain.

Conclusions

There are four components of the DTC in the Arab region:

1 Adoption of curriculum/model for the students' needs, country and the education system;
2 Developing the necessary educational materials (i.e. curriculum guidelines, teachers' guide, and students' manual);
3 Training of educational personnel (teachers, principals, and curriculum specialists); and
4 Facilitating the learning/teaching process of DTC in and out of schools (laboratories/workshop/stations, equipment and materials).

It had been found that validation of results, cooperation between schools, and departments, and the availability of financial resources ($25,000 for the initiation of the lab and $5,000 for the materials each year) are key factors in the expansion of DTC in the education system. The availability of competent teachers (committed to DTC philosophy) was very important.

The three countries (Bahrain, Jordan and Lebanon) have faced several problems during the early stages of project initiation. These obstacles can be summarized as follows:

- Selection of teachers: Teachers with a background in science (physics) and arts were found more attractive to DTC;
- Having enough time for teaching (classroom periods) for the teachers nominated for the DTC. In certain cases the teachers are required to teach this subject in more than one school;
- The basic education weekly schedule is full of subject matter. There was no room for new classes or subject matter such as DTC or practical applications, especially in grades 1 – 3. In all the Arab region, one teacher is teaching the whole class, except for foreign languages, arts and technology classes.

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BLANCO
FIBRA
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The 'Designerly Thinking Project': The Beginning of a Pedagogical Journey

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Abstract

This paper is a good opportunity to revisit the documentation I made of the Developing designerly thinking project based at University of Central England, Birmingham in order to look at what part of my pedagogical journey I am on now, what my journey has been thus far, and what part the project has played in my own understanding of children's learning. The Designerly Thinking project has been the main perpetrator in starting an ongoing relationship between my practice, research and reflection.

Documenting children's learning

What is made most pertinent, what is bought to the fore, and what is made 'visible' by the photographs, comments and the 'scribing' of children's talk, questions and discussion, is children's capabilities, imagination, creativity and thinking. The 'scribed' conversations and reflective comments, found in the documentation of the project, echo 'genuine dialogue' between myself and the children. It is as if I had been set free from the constraints of the classroom and from the rules and repetitious nature of classroom talk (in which I held the reigns and asked the questions whose answers I already knew). By collaborating on a creative project together, I entered into what the Reggio educators call 'the potential of being dangerous', the uncertain world of the unknown and the new, in which myself and the children learnt from each other through communicating ideas, thoughts, feelings. As such, my teaching entered into a new phase of genuine dialogue and meaningful, purposeful and genuine learning as opposed to a didactic, formal and 'stagnant' way of constructing knowledge.

"The string is attached to a wooden tube and the string is wrapped around it – you pull it" Alex

"We're learning about structure and things being stable" Anisha

"It's because it has four legs!" Ewan

My role as teacher

The Designerly Thinking project enabled me for the first time to have a dialogue with my pedagogical self; that is, asking myself what role I should play, what did I want to learn from the project and, moreover, what did I want to learn from the children themselves? With these questions as a starting point I wanted to become familiar with how

Figure 1: documenting children's learning

children came to understand the 'designed world' and how they would interact with me on the project. I was free to enter into the arena of the unknown, in which the children would be entrusted with the answers, the questions, the pace at which learning would move forward or sideways or spiral. My role as the teacher would be one of 'partner, nurturer, guide' (Edwards, 1998; 179) and as such my 'teaching' focused primarily on a question of how best children could learn in terms of 'designerly thinking', not how best to teach designerly thinking. I became focused on thinking as a process, one in which my role as a teacher would be that of expert to the children's 'apprentice', but with careful consideration given to constructing our understandings of design together as a collaborative, social and cognitive event.

This was a process best mapped out by observation, scribing ideas, thoughts and talk, photographing the development of the project and the collaborative work, as well as using these methods of documentation as a means of reflecting, revisiting and rethinking. The processes of children's ideas, thinking, action, collaboration were there to be discovered, uncovered and reached through exploration, discussion, action and creative endeavours between myself and the children, and between the children themselves.

Children as rich in resources, strong and competent

What the project made clear for me, and subsequent research and projects have reinforced, is that children are, as Carlina Rinaldi passionately articulates, "rich in resources, strong and competent… They have potential, plasticity, openness, the desire to grow, curiosity, a sense of wonder, and the desire to relate to other people and communicate" (Rinaldi, quoted in Edwards, C. et al 1998 p. 114). These are powerful words and need to be reflected in practice, and were, I believe, reflected in the project by the children involved. It seems of vital importance to return to what the children did, said and created in order to reflect upon the questions of what did we learn about 'children's thinking', about 'Design and Technology in the Foundation Stage', and about 'how to improve practice'. Furthermore, the answers that I found brought up new questions and new ideas of how to best promote children's learning, not just in terms of Design and Technology, but in terms of all of their modes of thinking, expressing and creating. In this way, the project enabled me to see my teaching and school as a changing, evolving, growing thing, which stood on the shoulders of previously understood practice and research, as well as an ongoing need to ask questions of ourselves, of children, of our practice and to continue to reflect on how best to encourage children's social and cognitive development.

The 'Designerly Thinking' project

The purpose of the project was to:

> *"develop 'designerly and technological' capability of Foundation Stage children, through teaching and learning. The main activities centred on developing 'designerly' thinking using a selection of familiar products; in addition, approaches to using the classroom and local environment, appropriate knowledge and understanding and making skills were explored."*

The Designerly Thinking development day enabled me to have a deeper understanding of how to use products (disassembling them, asking questions of them) in order to develop key concepts (materials, components, user, purpose, design, aesthetics, construction, structure, mechanisms) and how the 'making' element of design and technology could be more deeply imbedded with 'designerly thinking' when preceded by exploring made products. This became vital in 'framing' my teaching, as it afforded me the confidence found in a strong subject knowledge upon which I could build the foundations of questions, vocabulary and resources that would be the framework within which children could be free to express ideas, explore creatively, and be supported by myself. As a framework suggests boundaries and limits, I think the 'planning' of key questions, key vocabulary and 'possible avenues of learning' was more of a 'jumping off' point, from which children could construct their understanding of key concepts of design, free of the constraints of a set of preconceived notions of what they might produce; children were given time to envelope themselves in the process of their learning.

I was also interested in how to marry my own early years' principles (creativity, play, independence, exploration) with the aims of the project. I wanted to promote the use of the school environment, the outside classroom, and my own creativity as a teacher (trying to encourage children to use me as a 'tool' for their learning) in order to make visible children's learning. I wanted to encourage children's natural curiosity and questioning, giving them the freedoms of time, space and materials, to express themselves creatively, collaboratively and uniquely.

I planned out 3 weeks worth of research. The outline of the research looked something like this:

- Mechanisms and structures – exploring products and toys (week 1)
- Structures – making a flat picture stand-up (week 2)
- Structures or mechanisms – a 'big' project (weeks 2 and 3)

The 'big' piece of work for the project was reached by accident. I wanted to work on a large scale, work in the newly developed outside classroom, wanted to incorporate the school's 'secret garden' and wanted to use resources that children had already used in their play (in this case large water play – pipes, guttering). What was so enjoyable about this part of the research was that it was my reaction to all of these factors and to the children's play that led us to the final activity; the children and myself were co-creators in the activities conception. We came to think about how to create a structure for watering the plants in the secret garden.

At this stage I also started to reflect how involved children's play actually is. When playing they may be experimenting, hypothesising, communicating, co-operating and collaborating, they may be discussing purpose, design and exploring materials. With this I began to see an aspect of the project may be to look away from planning outcomes, but plan quality play opportunities which implicitly encourage 'designerly thinking'. This tied in very happily with my early years principles and practice as it pointed toward valuing play, toward the importance of play as the key to learning and teaching in the early years, and toward children being rich in creativity and competencies whilst playing.

Setting up the resources and giving children time and space, children began making a stable structure that could carry water from a high place to a low place. Children used wooden poles, string, sellotape, saws and plastic guttering to construct stable models. They attached guttering to their structures and evaluated their successes through pouring water down the pipes!

Children worked in pairs over 3 one hour sessions, which allowed time and space for children to explore ideas and to become involved in 'sustained shared thinking' with each other and myself. Children entered into genuine dialogue of sharing ideas, solving problems together and communicating and collaborating on their structures. Children drew on their own experiences of the word to reach new understanding, connecting bits of their worlds together ("it's like a camera tripod" and "we've made a roman table" were just two assessments of their creativity).

As a practitioner I was able to document the children's learning and reflect upon the possible processes they may have involved in their play – synthesis, evaluation and application as they tested out their structures in the secret garden. The high level of involvement in the activities over long periods of time, the creativity and imagination in the designs, and the depth of their play reinforced my belief of children as rich, powerful and competent. I was able to share in the children's joy and delight in their successes in the project and could come away with a clearer idea of how to develop my practice in response to the research.

The impact of the project on practice

There are both specific and general impacts of the Designerly Thinking project upon my own practice. The development of my own subject knowledge, a greater understanding of the specifically 'designerly' processes involved in design and technology, a greater understanding of how to use products effectively and what a rich resource the world around us makes, are all specifically about my own teaching in Design and Technology. There are more generic reflections that can be made about how best children learn, what environment is best suited to develop their many languages and what role adults (and other children) have in the construction of children's knowledge, understanding and attitudes.

The central importance of time, space, materials and relationships was made apparent by the project. Children require time to build, time to return to their designs, time to change and modify, time to develop their creativity and ideas, time to problem solve and time with adults who are readily available to children to use as a 'tool'. Children require a designated space to work alone or alongside others, with a well-resourced and easily accessible 'Design and Technology Workshop' in which they can plan their own play in, following their own learning agendas and areas of interest. Children need teachers to plan an environment within which they can engage with 'designerly concepts' and develop 'designerly thinking' through well-planned interactions with practitioners (teachers asking design questions, entering into genuine dialogue, spending time with children sharing ideas, thinking and skills and providing resources in response to children's

Figure 2: building structures and solving problems

Figure 3: relationships and participation – 'designerly' activities with parents, educators and children

own interests). Children need an environment in which collaborative creative play between parents, educators and children is not only valued, but sought out, encouraged and celebrated.

Similarly, spending my time on observing, talking, reflecting on how best to make children's learning 'visible' has become central to my everyday practice. Documenting and revisiting children's learning, giving myself time to observe, share ideas with and create a 'collaborative project approach' to learning has allowed me to take risks with my teaching. I allow situations to occur that become 'provocations for learning', which give children time to develop their own projects, which are a journey into the unknown, with children holding the compass and dictating the direction of their learning pathways. It is, as Rinaldi eloquently says, a way of "entering into the dark zone; an understanding of how we learn", which enables me to participate in "a metaphorical dance between teacher and child – a spiral of knowledge" (Rinaldi, 1998, quoted in Valentine, M. 1999, p. 8). Some of the child-initiated projects include : separating sand and water by building a wall, making a house for the worms to live in, building a boat and making a fire-engine – all of which have occurred because the 'conditions for learning' have been right. As Malaguzzi clearly states, the "objective of education is to increase the possibilities for the child to invent and discover" (Malaguzzi, quoted in Edwards C et al 1998 p. 83).

Endless possibilities

To return to the my own pedagogical journey, and where I am in terms of understanding children's thinking and learning, finds me in a place of 'questions'. The 'springboard' that the Designerly Thinking project afforded me, has given rise to a myriad of questions about teaching and learning, the roles of teachers and children in collaborative projects and the type of environment which encourages thinking, communication, creativity, exploration and imagination. In order to provide children with opportunities that are rich in 'provocation', so that they "actively construct knowledge and the tools for thinking and learning" (Wood and Attfield 1996, p. 106), I have to be a teacher who, as Nutbrown (1996) succinctly says, cherishes the growth of the young, through supporting, nurturing, facilitating and developing opportunity, exploration, response, interest and investigation. When my practice is full of 'research, reflection and revisiting' then it is one open to new journeys, new and unknown learning situations, and is open to the wonderful, surprising and endless possibilities of young children's thinking.

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Crossover Project 2004

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Abstract

At the heart of this project is the use of electronic communication during learning and teaching. The context-design and technology – was chosen for a number of reasons. It certainly provides an appropriate and relevant context and such a project and offers children real reasons for the need to communicate. The 'scene' was set for the children to construct a bridge over the river Severn at Ironbridge and to create a vehicle that could take people around the village, particularly those with a disability, for sight seeing. The vehicle would need to cross the bridge at some point in the tour. Schools were paired-one making a bridge, the other a vehicle, and the culmination of the project took place at Enginuity, Ironbridge Gorge Museum, when all the schools came together to see if their vehicles could cross their partner bridge. The project Crossover 11 has continued into 2005. This time the project is being undertaken in a way that ensures schools take ownership of it, without much face to face support. Most of the materials are web based and by Autumn 2005 all the materials, including video clips will be on www.wmnet.org.uk and anyone anywhere can access these and create their own project for their own locality.

School Background

Brookhurst Primary School is situated on the outskirts of Leamington Spa in Warwickshire. It is a two-form entry school with approximately 360 pupils aged 4 to 11 years on roll.

The school is dedicated to promoting child-centred learning through a hands-on approach. The Headteacher is keen to embrace new initiatives in order to help raise the standards of children's education. Currently, the school is involved in a project led by the University of the First Age (UFA), whereby children's individual learning styles, curriculum strengths and social skills are taken into account during planning. This involves teaching a range of skills and concepts in a variety of ways, incorporating visual, aural and kinaesthetic learning styles.

Design and Technology (D&T) has a key part to play in this developmental process as many other curriculum areas can be integrated including Literacy, Mathematics, Information and Communication Technology (ICT) and Science. At Brookhurst Primary School, D&T is taught across the age range from Reception, 4-5 year olds, through to Year 6, 10-11 year olds. The subject engages and motivates pupils through its practical nature therefore enhancing the learning experience.

The Crossover Project

The Crossover Project was a Design and Technology project that ran from December 2003 to Summer 2004. It involved Key Stage 2 (KS2) children aged seven to eleven from fourteen schools across fourteen Local Education Authorities in the West Midlands. The project was designed to support the achievement of WMnet's strategy and priorities. They aimed to build partnerships, through communication technology between organisations and schools, develop innovative content, and hold an online event, with video-conferencing, for the primary schools involved.

In order for the project to be successful, WMnet, a regional broadband consortium from the West Midlands, partnered the University of Central England in Birmingham, Enginuity, a 'hands-on' Science learning centre in Shropshire and Imagineering, a company specialising in setting up engineering clubs in Primary Schools.

The project proposed that schools would pair together, with one school designing and making a bridge and the other a vehicle, as part of their KS2 D&T curriculum. It was set in the context of designing a new tourist bridge for Ironbridge in Shropshire and developing a motorised vehicle to transport those who have difficulty in walking. The children were required to communicate with their partner school via the Internet, through E-mail and video conferencing. This communication would be vital to ensure the dimensions of both the bridge and the vehicle were compatible. The project would culminate in a Celebration Day where all of the schools involved would meet together to be judged on their work. The partner schools would present a short, jointly prepared PowerPoint presentation of the design and make process, finishing with the testing of their vehicles across their partner school's bridge. Prizes and certificates would be awarded for achievements in various categories.

Why the school took part

There were many reasons why Brookhurst Primary School took part in the Crossover Project. The school has a committed and enthusiastic D&T subject leader who enjoys being involved in the types of challenges that the Crossover Project had to offer. It was a great opportunity to raise the profile of D&T within the school. The school currently hosts an Imagineering Club, so there was the added advantage of having an engineering expert on hand to help solve any problems. In addition Crossover appealed to the Year 6 staff as an excellent way to motivate and engage the children after their Statutory Assessment Tests in May. The cross-curricular nature of the project meant that children could use their different skills to participate at a level that suited them. Along with the obvious links to the existing curriculum, it was hoped that the children would develop socially through communication and cooperation with their peers. The real life context added an extra dimension to the project with the introduction of design criteria, further challenging children's problem solving and reasoning skills. It would give them an opportunity to develop and refine these skills through a rich and rewarding learning experience.

How the project was run

The project was run alongside the existing unit of work for making a Controllable Vehicle. As the school has two classes of Year 6 pupils it meant that all children could share the same experience but only a selected few would be directly involved in the project itself. The project was presented to all of the children, with the starting point being an introductory DVD provided by Crossover which served to generate enthusiasm and potential ideas.

Initially, all of the children designed a vehicle that would meet the criteria set out. The design work was then displayed and evaluated by the children, with them giving marks against the criteria for each design. The vehicle chosen to be constructed was the one with the most marks awarded.

The next phase of the process was to assemble the teams that would be working on the project. Having already recognised their individual strengths through a UFA exercise, the children put their names forward for the team they would most like to be a part of. In order to have manageable, effective groups, each team had a maximum of six children.

The teams were:
Communication – responsible for E-mailing the partner school, receiving E-mails and communicating any information to the other teams.
Construction – responsible for the construction of the chassis, body and gearing of the vehicle.
Electronics – responsible for designing and attaching the circuitry that would drive the vehicle.
Technical Drawing / Design – responsible for making sure that the Construction Team followed the design accurately, producing technical drawings and designing the decoration for the body.
Technical Support – responsible for creating the PowerPoint presentation and liasing with the Communication Team.
Documentary / Photographers – responsible for interviewing team members and writing progress reports on the project as a whole, and for taking still and video pictures of the stages of the vehicle's construction.

All of the teams had to work together and take responsibility for their specific areas of the project. They also had to cooperate and communicate effectively with the partner school to ensure that the vehicle was suitable for the bridge and vice versa.

Once the vehicle was completed and tested, a final team had to be chosen. This team consisted of one elected member from each of the six teams that were involved in the project. These would be the children who would present the vehicle at the Celebration Day, talk to the judges and evaluate the success of the project as a whole. Following the Celebration Day an assembly was held in school to further celebrate the success of the project. The final team presented the Crossover Project enabling the children to share their success with the whole school community, including a representative from Warwickshire County Council.

Successes

The Crossover Project was a great success in all it set out to achieve. Essentially, irrespective of its educational value, all of the children involved in the project had tremendous fun. They enjoyed working with each other and making strong links with another school. It provided an excellent challenge, having to think carefully about restraints and limitations put on the vehicle by the criteria that were set. The children's ICT skills were tested through sending and receiving E-mails, downloading digital photographs and preparing a professional presentation. It demonstrated effectively how many people are involved, and the level of cooperation needed, in the manufacturing of products. The project broadened children's overall understanding of the design and make process, particularly the need for good quality designing and accurate construction in order to meet the brief successfully. Finally, it gave the children the opportunity to develop and refine both their social and academic strengths.

Future Developments

The teamwork approach was very effective for this project and could be improved further through having team leaders and project managers to give regular progress reports to the rest of the groups. A crucial development would be to set aside more time for the project, in order to incorporate more Focused Practical Tasks. Although the children had some prior experience in using the materials and tools available, they would benefit greatly from more practice in specific key skills. This is especially true when designing and making the gearing mechanism. A session with an expert in this area would allow the children to become familiar with this more difficult concept. An extra challenge would be to introduce cost limitations on the materials available to use. This would encourage the children to think carefully about their original designs and the implications for the construction of the vehicle.

Crossover II

Following the success and enjoyment of the first Crossover Project, Brookhurst Primary School is taking part again in 2005. The format is slightly different in that schools are given the choice of their partner school, meaning they can be more locally based. They will organise and hold their own Celebration Day and importantly, submit the plans, outcomes and evaluations for posting on-line, giving schools nationwide and internationally the opportunity to run their own projects in the future.

This adds additional challenge and excitement to the project, allowing schools to tailor the criteria to suit their individual needs. Schools involved will still be able to access the on-line support and advice provided by WMnet, which proved invaluable during the initial project.

The pupils and teachers of Brookhurst Primary School look forward to the achievements that will come from Crossover II.

Developing a Resource for Schools

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Abstract

It is always a valuable experience for students to undertake projects that are related to, but extensions of, their course. The opportunity arose for students to opt in to a project to produce a web based resource for CITB. It was to be based around construction and structures but also had to be linked to the Back to Back National Trust housing project in Birmingham. As the resource would be available worldwide for teachers to use, it had to be appropriate for any situation, whilst having a local flavour.

For those interested in seeing the resources contact clare.benson@uce.ac.uk. At the time of this publication, the CITB website was undergoing change and the updated address unavailable.

Introduction

We are currently Year 3 BA (Hons) Primary Education with QTS students at The University of Central England. During our second year of studies we were offered the opportunity, through Professor Clare Benson, to take part in a project funded by the Construction Industry Training Board (CITB) to write and develop a series of lesson plans based around the renovation of some Back-to-Back houses by The National Trust that are situated in the centre of Birmingham. To discover more about these houses see www.birminghamuk.com/back2back.htm.

We initially discussed our plans as a group and felt there was something lacking in the schemes of work that teachers taught in design and technology. Therefore, when we were approached by CITB to develop our project we decided this was our perfect opportunity to introduce the missing elements. We felt that current schemes were too focused on the final product and did not place enough emphasis on the 'designing' or the 'technology' elements of a project. So to achieve this we went back to basics. We looked at products that would be interesting while still being simple enough to base work on and which would teach children about the way products are made in the real world. We looked at past products which had been developed and adapted to fit in with changing living conditions; things such as hinges, chimneys, guttering and windows. These products would allow children to develop a good understanding of how products used to be made and how they are made today. They would also provide a good setting to allow children to understand how technology has changed and is still changing.

Our schemes of work provided opportunity for children to work as 'Designers'. Through using well established products such as hinges or windows children are forced to be creative and imaginative as the basic product is already in place. Therefore they are not expected to start designing a product from the beginning and can spend more time on the creative and imaginative aspects of the projects. We aimed to provide time for children to develop as designers because they would not be designing a completely new product and so would have time to design, develop and modify their designs as the project progresses. We believe this will give children a more realistic understanding about how products are designed in the real world.

We also aimed to reduce preparation time for teachers. We are aware that 'design and technology' can be a time consuming subject in terms of resource preparation. Therefore, we aimed to use products that could be easily found in accessible places, such as around the home or school and which could easily be bought or borrowed for children to experience as a primary source.

Prior to writing our schemes of work, we carried out research into what products and resources were available to include in our plans. In order to carry this out we looked at various websites that related to the topics we were thinking of covering. We spent some time looking at other schemes of work, e.g. QCA to investigate how much information they offered teachers as to what resources are available for each unit of work. Between all of us we had various relatives and friends who are currently teaching in primary schools and using these available schemes of work when teaching design and technology. We were able to ask them what other resources they felt would be beneficial to them within the classroom. One such example that was given to us was that of a 'model' process diary they could adapt for whichever year group they were teaching. All of our lesson plans offer this. Another example of a useful resource was some 'useful websites and books' that would offer further information that would both enhance the children's knowledge and understanding as well as supporting the class teacher's subject knowledge. During our design and technology specialist lectures at University we discussed and looked at the area of questioning children. As a result of this lecture we were all encouraged to think deeper about how we question children in order to gain the relevant information and extend their thinking and learning. We discussed the thought that there may be some practicing teachers who do not always give this area of their teaching sufficient thought and so decided to include some information relating to questioning children and some examples of 'useful questions' within our schemes of work.

We felt it important to be able to make the schemes accessible to a variety of schools by offering a realistic choice for teachers. Each scheme of work includes an overview which provides teachers with a brief outline of the learning objectives, expected learning outcomes and activities involved in the plans, along with a variety of ideas for adapting the scheme to fit in with the constraints of the school/classroom.

Both detailed medium and short term lesson plans have been provided for Key Stages one and two. Ideas for using elements of the scheme as activities in the Foundation Stage are also included. Each unit provides a brief outline of the National Curriculum links and alternative contexts for the design and make element. Specific sections are included detailing the three D&T areas:- IDEA's, FPT's and the DMA's. The schemes provide cross-curricular links and out of school/homework activities.

The lesson plans are all written in the same format and incorporate details of learning objectives and outcomes, teaching and learning activities, assessment opportunities, related vocabulary, resources required, key skills to be developed, classroom organisation and further notes which give information about health and safety issues.

Resources and background information for the lesson plans are accessible in an easily printable format. These resources include pictures, worksheets, questions banks and presentations. Suggestions have been made for places to visit, or collect resources from and websites with supporting information are given.

During an assignment we had to complete as part of our course, we were provided with an opportunity to team teach our own schemes of work at a local school, Bearwood Infant and Junior school in Smethwick, Birmingham. We were allocated Thursday afternoons over an eight-week period, to include an experience in each Key Stage with one lesson acting as an observation. The schemes chosen for teaching were:

- Hinges (Year 6)
- Guttering (Year 6)
- Candle Holders (Year 1)
- Rag Rugs (Year 1)

The first hurdle we had to overcome was the lack of time. The schemes that we had initially devised were intended to be taught over six and eight one-hour lessons, whereas we were given three afternoons to teach each scheme. This is a common problem that teachers find in schools and this gave us the opportunity to see how adaptable our schemes were. Being aware of how important the design process is in teaching children new skills, we made sure the lessons on Investiaget, evaluate, activities (IDEA's) and focused practical tasks (FPT's) were included to the full. However, this meant that the final 'make' was squeezed into a one-hour lesson. With excellent assistance from a dedicated classroom team all the children were supported sufficiently to enable them to finish their designs and products.

Thanks to the flexibility of the staff at Bearwood Primary school some aspects were included in other subjects. The design for the front covers of the children's books in 'hinges' was undertaken in an ICT lesson in our absence. The design for the back boards of the children's 'guttering' projects were completed as part of an Art lesson, also in our absence. The resultant high standard of presentation of the final products served as an additional motivating factor for the children.

Our concerns over motivating other students, not directly involved in our initial project, to teach and follow our lesson plans proved largely unfounded. Though they were initially less confident in teaching our schemes, they had been expecting to teach QCA schemes of work, with encouragement and careful support from the authors they proved to be great assets to the trialing of our lesson plans. The students who were not directly involved with the writing of the schemes of work felt able to comment on how easy our plans were to understand and adapt as well as suggesting additional information to consider including.

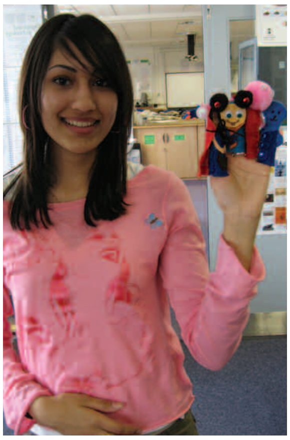
It became apparent throughout this teaching experience how important the role of the Subject Leader is in motivating the team and setting the required standard. It is necessary for whoever is taking that role possess knowledge of all aspects of the scheme being taught, not least so that they can impart confidence to teach the lesson to the teachers. To facilitate this, the schemes needed to provide sufficient detail on many aspects, including provision of clear guidelines of the objectives, the resources needed stimulus for motivating the children and how to achieve an end product of suitability high standard.

During our school experience we became even further aware of the importance of the types of questioning used in classrooms. As we had previously discussed and thought the utilisation of questions that might develop higher order thinking skills proved very useful in extending the children's deeper thinking and reasoning.

Grouping of the children was clearly a significant issue as we discovered it to have a direct effect on the level of the children's learning. During the IDEA's part of the process it became apparent that the children were learning more by working in groups. However, in mixed ability groups they were able to scaffold the learning, encouraging all children to participate and learn. In comparison during the FPT's the children were more focused when they worked in pairs because though they could still discuss issues they spent more time on the task. It did not seem to be of particular importance if these pairs were based on friendship or mixed ability as long as a process of scaffolding the learning was encouraged. When the children made their final designs they mainly chose to work alone.

As a result of having the opportunity to take part in this project we all feel we have learnt much and believe it has improved our teaching and thinking of the importance of design and technology in primary schools. By being able to 'trial' some our schemes of work within the classroom, even if under very limited time, we were able to see how easy they would be for other people to be able to use. Comments offered by our colleagues who had not taken part in the project offered us further insight into this. We all believed prior to this project and still do that effective planning and the use of a range of resources are very important in design and technology lessons, especially in the early stages when the children are looking at examples of similar products and ideas to what they wish to construct. Writing our own schemes of work should not give others the opinion that we do not think the QCA and other schemes of work available are not exemplar and we will never use them. We will, but we also believe that the more information and suggestions of ideas can only improve the excellent design and technology teaching that already takes place within primary education, most of which is based around or follows strictly these already available schemes of work.

NOTES / CONTACTS



Further Information

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