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Joining with industry: innovative curriculum materials for technology and science for primary schools

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Abstract
There is a perceived need for curriculum materials that would support primary teachers taking up work placements. Primary classroom materials of this kind should encourage children to be innovative, develop analytical and problem solving skills and be pro-active towards their own learning. The rationale for the development of such a pack of curriculum materials for primary technology and science is discussed in relation to the educational and curriculum contexts of the materials and the ways in which innovative qualities can be developed in children through the use of 'real' contexts for classroom-based work. The way in which product analysis can be used to facilitate understanding of innovation in the world of work is examined and some exemplar activities are provided.

Introduction
The relationship between the 'World of Work' and the primary curriculum has become increasingly exploited as primary teachers recognise its value for educational activity and the National Curriculum has identified the importance of using the wider context of the world of work. A pack of curriculum materials for technology and science has been developed to help teachers implement classroom-based curriculum activities focussed on industrial contexts. The materials offer support to primary teachers who may be engaged in industrial placements and are intended to encourage creative, investigative and problem solving abilities in children.

In preparing the curriculum materials an examination of the potential of particular industrial and commercial environments as themes for science and technology activities was undertaken. This idea was linked with the belief that innovative qualities could be fostered in children through an approach to the curriculum that considered carefully the learning environment that the children were immersed in and viewing the development of independent learning as crucial. The materials, extracts from which are included later, attempt to bring together these strands in a meaningful way that is accessible to the primary school practitioner.

Educational context
Brandes and Ginnis (1986) clarify seven steps in the process of innovation. These are maturation, establishing trust, assessment, resistance, awareness, problem solving, and contracts. The steps do not necessarily occur in any particular order - they are interwoven and may sometimes seem to happen simultaneously. The processes suggested here for carrying out the curriculum activities use this structure to focus on the development of particular learning characteristics in children. These key characteristics are creativity, investigative ability and problem solving skills.

The promotion of creative abilities is increased in an environment marked by fun, humour, spontaneity, risk and intention (Brandes and Ginnis, 1990) and it is proposed that teachers generate a classroom atmosphere that engenders these features. The materials do not tell teachers in rote fashion how to do this but suggest that they are important and rely on their personal professionalism to plan appropriately for the needs of their particular circumstances. This presumption about the professionalism of teachers is prevalent throughout the materials.

The materials encourage educational methods which seek to promote the growing responsibility of the learner and emphasise the learner's own activity and learning styles. Within this context the materials present the basic characteristics of 'active learning' as an emphasis on learning by doing and an emphasis on the child making the decisions (Waterhouse, 1990). It is important to recognise within the planning methodology suggested in the pack that individual differences are multi-dimensional; they include cognitive differences, personal differences and social differences. A flexible learning approach meets the individual needs of children and encourages children to take responsibility for their own learning.

The educational premise for these materials is that children's affective and cognitive growth are enhanced by group work. Effective learning is achieved through 'doing'. These ideas link with the practical nature of both science and technology in the professional world. Human beings are adept at
controlling the environment. This they do by:

- Coping with change: adapting behaviour to changing circumstances, being able to answer the question 'What would you do if...?'
- Communicating: using symbols to convey meaning to others - language, mathematics, pictorial signs
- Predicting: being able to look ahead, to visualise events and anticipate the future; seeing what might happen next.

(Fisher 1987)

The development of these abilities by structured engagement in activities is an important feature of the materials. These set out to foster interactive problem solving of the kind that helps to make children independent learners. Problem solving emphasises the development of qualities such as curiosity, resourcefulness, independence, tenacity and patience and it develops confidence in decision making and the ability to work with others. It can make learning fun.

There is no set formula for problem solving within the materials although the National Curriculum documentation in both science and technology has much to say about the process.

Curriculum context

Many of the above qualities can be extended through the context of the world of work. National Curriculum Council (1990) identifies that Education for Economic and Industrial Understanding is an essential part of every pupil’s curriculum. It helps children understand the world in which they live and emphasises practical activities, learning through experience, and the exploration of values and beliefs as well as providing relevant contexts through which subject knowledge and skills can be developed. Analytical, personal and social skills are emphasised for example by:

- an interest in economic and industrial affairs
- respect for evidence and rational argument in economic contexts
- concern for the use of scarce resources
- a sense of responsibility for the consequences of their own economic actions, as individuals and members of groups
- sensitivity to the effects of economic choices on the environment.

(National Curriculum Council, 1990)

The subject aspects of the National Curriculum also show concern for the inclusion of those values considered to be important in this area. The curriculum required for science identifies the following:

"To communicate, to relate science to everyday life and to explore are essential elements of an initial and developing experience of science."

(DES Science, 1991)

Reference to the development of science through investigations and case studies using industrial contexts is found in DES Science (1991) and in the Technology National Curriculum (1990).

"Pupils should be able to identify and state clearly needs and opportunities for design and technological activity through the investigation of the contexts of ...... business and industry."

(Technology National Curriculum, 1990)

The development of innovative qualities can be encouraged in children through an evaluation of the process, products and effects of design and technological activities. The product analysis sections of the materials focus on these issues and Attainment Target One in the Order for Technology require this kind of contextual analysis.

The Curriculum materials

Rationale

At the inception of the work a number of guiding principles were established which were used to test ideas as they were conceived and developed. It was decided that the materials should be designed to be as “user friendly” as possible. It was not appropriate to include long theoretical discussions about the claimed advantages of this approach; minimum words was the aim. The focus of the materials would be the processes of innovation as seen in science and technology and not the products which result from innovative activity. The children’s thinking and creative abilities should be challenged. An open ended and innovative approach to the teaching methodology that was used in implementing the activities was encouraged as were flexible teaching and learning methods.

There is a danger in just mailing information to schools. Even the best materials will often not reach the teacher they are designed to help. Therefore, materials should only be available for teachers taking placements in industry and should be supported by training. The materials would be used primarily by
those teachers seeking placements in work contexts identified in the curriculum package.

Designing the curriculum materials
The process of designing the materials focussed on how the requirements of the National Curriculum Orders in Science and Technology for Key Stages one and two could be met starting from an industrial context. It was anticipated that the majority of those using the materials would be participating in an industrial placement and would be looking for ways of using their experiences effectively back in the classroom. The materials provide some initial ideas and act as a stimulus for further ideas which could be developed. An understanding of the meaning of innovation in the primary curriculum was essential.

Innovation
Within the materials the focus is on the development of innovative qualities in the children by carrying out science and technology activities in the classroom related to the world of work. Innovation is achieved within the activities through the development of creative, investigative and problem solving abilities. A range of qualities that children would be developing when carrying out the activities has been identified. These include:

• having a clear goal
• dealing with problem situations;
• overcoming obstacles;
• bringing about desired effects;
• communicating effectively;
• analysing and synthesising;
• developing evaluative and self critical abilities.

The learning environment
It is important that the learning environment assists teachers to engage the children in a way that encourages them to become more innovative. In order to foster the abilities identified, the teacher must help children to become more responsible for their own learning within flexible teaching and learning structures. This means that the children should be involved in:

• working together in groups, in pairs;
• discussing ideas in pairs, groups or as a whole class;
• debating;
• presenting ideas to peers, and adults other than teachers e.g. people from local business;
• reviewing their own and others’ work;
• using drama and role play;
• using a range of data-gathering methodology e.g. CD-ROM, databases, and libraries.

The key feature of the learning environment is engagement with structured, yet open-ended activities. The means of developing innovative qualities lies within this learning environment and the way in which the teacher establishes the context for the activity and guides the child through the work. There is a fine balance between teacher intervention and child autonomy. The nature of the activity is obviously important but even the best activity would be unsuccessful without skilled implementation.

Self assessment
Self assessment by the child forms a central part of this philosophy. The assessment component of the activities is created to encourage pupil self assessment and personal reflection on performance. Within this general framework a number of assessment methods were used. It is envisaged that children would:

• use pupil profiling schemes: 'I can do...........';
• design and making their own records;
• assess each other’s work.

This process of self-reflection is critical to the children establishing innovative approaches. Without some personal measure of performance it is impossible for them to distinguish the innovative ideas from those which, whilst creative, are impractical. Science and technology provide a learning environment which engenders self-reflection. An innovation and its consequent innovative thought processes must include a practical element to be successful.

The activities
The National Curriculum in both Science (AT 1 ‘Scientific Investigation’) and Technology (AT 1 ‘Designing’ (DFE, 1992)) focuses on children who carry out investigations and attempt the solution of practical problems. Each of the activities in the curriculum package provides guidance in developing this kind of work. Teaching ideas are identified from work contexts with each activity being illustrative of work that could be carried out as a result of a placement. Three work contexts were selected as characteristic of placements that teachers were likely to be involved with. These were:

Communication
Health
Manufacturing.

As part of each activity there is a ‘product analysis’
which attempts to get the children to look more deeply at an innovative product from within the work context. This strand in the activities is intended to add breadth to the work and is described in more detail in the following section.

Product analysis

Product analysis is seen as a way of helping children to examine the technological world around them. It will enable them to examine how products are made and the effects that advances in science and technology have on a product line. An important dimension to this work is an analysis of the social implications of the development of the product. In developing this area of the work a range of criteria was established which could be used.

Analysis Criteria:
- i. INTENT - What the product is intended to do?
- ii. MATERIALS - What is the product made of?
- iii. MAKING - How was the product made?
- iv. USE - How well does the product work or how does it fail in action?
- v. DISPOSAL - Where will the product go when it is finished with?
- vi. INNOVATION - In what ways is the product innovative?

Historical Development Criteria
- i. How did the product get this way?
- ii. What of the social effects of past developments?
- iii. How has the making of the product affected employment, skills, environment, resources?
- iv. How has its ‘use’ affected the user, other people, the environment, other products?

Future Prediction Criteria
How might future changes affect:
- the making of the product
- the materials required
- the product itself
- the use of the product
- the disposal of the product
- other products

The materials give an example of these in use.

Each of the areas described above - Communication, Health and Manufacturing identifies possible activities for the teacher to translate into classroom practice. It is assumed that experienced practitioners will be using the materials. Below is an extract of the content from one of the activities within the work context of Manufacturing.

Science activity - Fasten It Up

Aims
1. To compare materials of different types and to explore the properties of these materials in relation to use.
2. To carry out an investigation and develop observational skills.

Classroom activity

The children should sort through a collection of ‘fastenings’ and discuss how each one works. They could classify the fastenings in different ways, for example, the material they are made from or the materials they are used to join, or the way they join. Close observations can be made of fasteners using hand lenses. How do zip fasteners and Velcro fasteners work?

An investigation could be planned to find out:
- “which is the stickiest tape?”
- “which is the strongest lace?”
- “how strong is the Velcro?”

Encourage the children to work in groups to set up a ‘fair test’ and identify variables to be controlled.

Resources
A variety of ‘fastenings’ - Velcro, zip fasteners, buttons, post-its, paper clips, split pins, laces, glues, bulldog clips, metal studs, hooks and eyes, screws, nails, sticky tapes, Blu-tack.

Hand lenses.

Review/evaluation

Innovation
Post-its, Velcro, Blu-tack, rucksack fasteners.

Product to analyse
Zip fasteners.

Design and technology - garments for you
and me

Aims
1. To examine how garments are made and make garments for a specified purpose.
2. To examine different types of fastenings on garments.
3. To explore how children are influenced by fashion.

Classroom activity
Children could explore the aesthetic and mechanical properties of textiles, identifying features such as colour, texture, durability, shrink resistance, kind of garment where a particular textile might be used.

Children could take apart old garments and look at the shapes of the pieces and how they were joined together. They could use this knowledge to design and make paper clothing for themselves. This could be for some kind of sporting activity.

Different kinds of garments have different purposes. For example police and fire officers clothing have specific functions associated with the job - identification, protection; aprons are worn for protection and hygiene.

The children could identify a range of ‘special-purpose’ garments and discuss their properties. They could analyse their findings and look for common and distinctive features.

Using this knowledge the children could design and make garments for specified purposes e.g. to design a rainhat for teddy.

Resources
Brown wrapping paper, newsprint, stapling machines, fabric offcuts, pins, needles and thread, PVA glue.

Review / evaluation
A class discussion could be initiated in which children express opinions about their findings on garments. They could hold a ‘fashion show’ of their favourite garments and / or of their own garment designs. Children could also explore garments from other cultures and discuss their aesthetic and functional qualities in relation to their countries of origin.

Example of innovation
Flame resistant fabric, ‘breathing’ fabrics, welding of synthetic textiles, cross-cultural garment design.

Products to analyse
Shell track suit, garments.

National curriculum references
Science
Activity - Fasten It Up.....
AT 1 - Scientific Investigation
AT3 - Materials and their properties. Children should explore the properties of a variety of everyday materials. Children should be able to link the use of common materials to their simple properties.
KS 1/2 PoS, i

Technology
These materials are being written at a time when the Order for Technology is in the process of revision. Consequently the National Curriculum references are to the ‘Consultative Document’ published in December 1992.

Activity - garments for you and me
Technology
AT1 - Designing
Levels 1 to 5 all statements
AT2 - Making
Levels 1 to 5 all statements
PoS - Core Making
Construction Materials and Components

Notes
Embedded in the description of the development of the curriculum materials is a teaching style which is aimed at developing innovative qualities, a flexible learning approach by the children and a methodology that accords with the requirements of the National Curriculum. Comment on our work would be appreciated and we would enjoy a debate on the ideas which we propose.

References
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