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Open Primary Technology: Teacher Education for Teachers of 5–11 Year Olds by Open and Distance Learning

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Introduction

This paper considers the professional knowledge required by elementary school teachers of technology. In particular, it focuses on two open and distance learning courses offered by the United Kingdom's Open University. These are *E626 Design and Technology in the Primary Curriculum* which is a course for experienced teachers, and *E880 Teaching in Primary Schools: Technology Module* a subject-specific element in the new ITT Primary course.

The Open University was founded in 1969. For more than twenty-five years it has produced distance teaching courses which combine text, video and audio elements in a mixed-media format. Students are able to study at home or their places of work for degrees at undergraduate and postgraduate levels and for a range of other vocational and professional qualifications. The university also produces resource packs of audio-visual and text material which are of general interest. In 1995 well over 200,000 people studied with the Open University. Through a long association with the BBC, which has its own production centre on the university campus in Milton Keynes fifty miles north of London, the Open University has earned a reputation for the high quality of its courses in both academic and production standards. Courses, which are designed and produced centrally, are supported by local part-time tutors through a network of study centres covering thirteen regions of the United Kingdom.the ages of 5 to 11 years, pupils in England and Wales study the same D&T curriculum. They undertake the following activities;

- assignments in which they design and make products;
- focussed practical tasks in which they develop and practise particular skills and knowledge;
- activities in which they investigate, disassemble and evaluate simple products. (DfE/WO, 1995, p2)

They work with a range of materials including stiff and flexible sheet material, reclaimed materials, textiles, food and construction kits. There is no fixed time for the study of D&T, but the quantity of work to be covered suggests that 1.25 hours per week are needed at the elementary school (Key Stage 2) level. There are two attainment targets; Designing and Making, and a programme of study specifies the design skills, making skills and the areas of knowledge and understanding which should be taught.

What Sort of Knowledge Do Primary Teachers Require?

Since the mid-1980s there has been considerable discussion and a growing body of research on the forms of knowledge required by teachers in performing their role (Shulman and Sykes 1986; Shulman 1986; Grossman Wilson & Shulman 1989; McNamara 1991). These different forms of teacher knowledge for design and technology teachers have been described elsewhere (Banks, 1996). I summarise the categories here:

Subject Content Knowledge

As is indicated in the introduction, design and technology in England and Wales is a very broad subject. However, teachers need to have a good understanding of a substantive part of the subject to serve their pupils properly.

The understanding of subject must be 'flexible and sophisticated' to include the ways in which the subject is conducted by academics within the field, 'to draw relationships within the subject as well as across disciplinary fields and to make connections to the world outside school' (McDiarmid et al 1989, p.193).

Teachers' subject matter knowledge influences the way in which they teach, and teachers who know more about a subject will be more interesting and adventurous in their methods and, consequently, more effective. Teachers with only a limited knowledge of a subject may avoid teaching difficult or complex aspects of it and teach in a manner which avoids pupil participation and questioning and which fails to draw upon children's experience.

Pedagogical Content Knowledge

This knowledge is often given labels such as 'subject application' in government documents (DfE 1992), but I use here the term 'pedagogical content knowledge' after Lee Shulman.

Shulman states:

> 'Within the category of pedagogical content knowledge I include, for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations and demonstrations – in a word, the ways of representing and formulating the subject that makes it comprehensible to others.' (Shulman, 1986)

Curricular Knowledge

There are currently at least four published schemes for teaching national curriculum Design and Technology for High School pupils in England and Wales but currently only one, the Staffordshire Technology Education Project (STEP), for elementary schools.

- Knowledge of subject content is necessary to enable the teacher to evaluate text books, computer software and other teaching aids and mediums of instruction. This is the materia medica or pharmacopoeia, as Shulman puts it, from which teachers draw their equipment that present or exemplify particular content.

School- Subject Knowledge

To these types of teacher knowledge I would wish to add 'school-subject knowledge' (see Banks et al 1995).

By altering technology to make it accessible to learners, a distinctive type of knowledge is formulated in its own right – 'school technology'. In the same way that school science has differences from science conducted outside the school laboratory, so school D&T is different from technology as practised in the world outside the school.

As a 'subject designed by committee', the school knowledge of design and technology is particularly specific and rarely exists as a coherent body of knowledge outside the classroom. But the subset of technological knowledge which is 'school technology' is a function of the schooling process and so would exist even without a national curriculum to guide its formulation. 'School knowledge' in the way it grows out of any general body of knowledge is inevitably changed. It is codified, partial, formalized and ritualised. Learning in that context is assumed to be programmable, defined in the form of a text, syllabus or national curriculum, with a conception of learning that implies a beginning and an end, an initial state and a final state. However, knowledge in general can rarely be sequenced in the same way as school knowledge and, generally, learning is far from being linear.

These different categories of teacher knowledge for primary teachers of D&T and the elements covered within the Open University courses are summarised by Figure 1. The diagram tries to indicate the synthesis of these types of teacher knowledge and I recognise the inadequacy of the picture. One might initially see "school knowledge" as being intermediary between subject content knowledge (knowledge of technology as practised by different types of technologists) and pedagogical content knowledge as used by teachers ('the most powerful analogies, illustrations, examples, explanations and demonstrations '). This would be to underplay the dynamic relationship between the categories of knowledge implied by the diagram. For example, a teachers subject knowledge in enhanced by their own pedagogy in practice and by the resources which form part of their curricular knowledge. What teacher has not confessed to only really understanding a topic when they had to teach it to others! All these types of teacher professional knowledge are strongly influenced by the personal subject construct of the teacher.

Personal Subject Construct

The past experience of learning technology, a personal view of what constitutes 'good' teaching and a belief in the purpose of D&T for all underpins a teacher's professional knowledge. This is true for any teacher. In particular a student teacher in ITT has to question his or her personal beliefs about their subject as they work out a rational for their classroom behaviors. But so must those teachers who, although more experienced, have undergone profound changes of curriculum emphasis during their career. Figure 1 is useful in trying to clarify the different aspects of professional knowledge which a student teacher needs to develop as he or she moves from novice to expert.

How Do the OU Courses Cover These Types of Teacher Knowledge?

Personal Subject Construct

From Figure 1 it is apparent that the 'personal subject construct' is initially tackled directly in both courses by asking the question "What is Technology?" The INSET (E626) course spends a considerable time in addressing the relationship between *design* and *technology* and in considering why technology should be in the elementary school curriculum. It gives a four point rationale:

- Pupils need to be exposed to part of our culture in the *technological world*
- Pupils need to be informed citizens who are able to question *technology's influence in society*
- Children need to be aware of the *economic imperative* which suggests that technological knowledge is important for wealth creation
- A problem-solving process which comes naturally from technological tasks is a good vehicle to promote *learning-related* activities.

The ITT course takes a similar line but spends more time asking the student-teachers to consider their own experiences of design and technology.

Figure 1

Open university Technology Education Courses

E626: Design and Technology in the Primary Curriculum (INSET)

E880: Teaching in Primary Schools- Technology Module (ITE)

School Knowledge

(related to the way subject knowledge is specific to schools) for example:

E626: Curricular views about the nature of technology; Matching of activities to the national curriculum; What opportunities for learning does technology offer?

E880: Design and Technology in the national curriculum

Subject - Content Knowledge "Technology" *for example:*

E626 & E880: A Technology Activity; "The problem of the two eggs"
E626: The Process of Design, The product Cycle, Kinds of modelling Systems Thinking
E880: Technological capability for teachers; Structures; Control & Energy; Food

Personal Subject Construct

E626: What is Technology?; The relationship between Design and Technology?; Why is Technology in the Curriculum?

E880: What is Technology? Your own school experience of Technology

Curricular Knowledge

i.e knowledge of resources for the classroom, for example:

E626: Case Studies of topics on Homes, Hats ads Systems (growing cress)

E880: Case Studies; Introducing Design and Technology tasks to children; Developing children's ideas; Gender issues.

Pedagogical Content Knowledge

i.e "subject-specific strategies to organise learning, most useful forms of representation" for example:

E626: Case studies; Simulating a Commercial activity; questioning; Planning for the development of Technological capability.

E880: Case Studies; Introducing Design and Technology tasks to children; Developing children's ideas; Gender issues.

School- Subject Knowledge

It will be apparent that the wide view of design and technology adopted in England and Wales embraces many aspects, such as food technology, not considered as part of the subject area in other parts of the world. In the United Kingdom is a strong tradition of teaching a range of curriculum subjects using a “topic” approach. A topic such as “Transport” or “Vikings” will both relate to maths and D&T, for example, as they do to the more obvious subject links of science and history respectively. The OU courses provide guidance to ways in which classroom activities within topics can link to coverage of the national curriculum.

Curricular Knowledge

There are currently only limited examples available of curriculum resources for design and technology and very few published schemes for elementary schools. In the UK, government authorities give guidance to what they consider to be good practice in teaching and learning, but generally do not produce classroom materials for teachers to use. That is left to commercial interests, and the swiftly changing curriculum of recent years has made publishers reluctant to commit resources to the production of high quality materials which teachers might consider to be ’out-of-date’ too quickly. E880 and E626 have tried to illustrate the use of curriculum resources by giving a selection of case-study examples, using both video and written descriptions. Both exploit the case-study of the manufacture of model Homes to show Lego, Quadro and simple construction techniques in wood strip and card. E626 in addition shows the production of an artefact (a hat) and an example of a system in the growing of cress. E880, being a later course, was able to use illustrative written resource material from the STEP published scheme.

Pedagogical Content Knowledge

The case studies are also exploited to illustrate teaching and learning strategies. The way that teachers need to consider the planning of work, the careful introduction of the tasks to children and their questioning of pupils during the supporting of the practical work is considered in considerable detail. Experienced teachers are already very used to developing children’s ideas in art and are adept in the classroom management issues associated with such practical work. However, supporting children through the processes of design and technology is something which is new to many teachers and the confidence to do that is encouraged by the student-teachers themselves engaging in a technological task.

Subject Content Knowledge

The case study examples contribute to the student-teachers subject knowledge and understanding. However it is important for teachers to understand how D&T processes impact on the subject by they themselves engaging in a project. In this way the appropriate pedagogy for design and technology is underlined and the various elements of professional knowledge are brought together. The following is a extract from both courses which share the same practical task:

Reg's Problem

This is the story of Reg who lives alone in a first-floor flat with access via stairs. He is healthy and agile enough to take a twice-weekly walk into town where he buys his food and other supplies. He carries his shopping in a soft bag that he finds far more convenient that a rigid basket. He has just one problem with this: he likes to buy just two, fresh free-range eggs from the local health shop each time he goes to town. He has tried using a conventional six-egg box but feels it unnecessarily bulky. He has had several mishaps and, for various reasons, feels that an improved carrier for two eggs must be possible (see figure 2)

1 Undertake the following design brief:

Design and make a prototype of a two-egg carrier that will satisfy Reg's need. Record your feelings about undertaking the task as well as recording the progress of your design. It is important that you do this activity practically [...]

2 Next, take time to reflect on how you worked on the given task.

3 Now, relate the experience you have just had to the way you will need to set up learning experiences for the children you teach, that is, to your teaching strategy.
(Open University,1994, p7–9)

The courses are able to use the students experience on this project to consider issues of motivation, practical knowledge, pedagogy, use of resources and the coverage of the national curriculum.

The synthesis of aspects of teacher knowledge implied by Figure 1 is also illustrated by the cross-referencing to different types of knowledge in the above descriptions. An activity such as ’Reg’s Problem can initiate discussion of subject knowledge, pedagogy and affect a student’s ’personal subject construct’.

Conclusion

This paper has outlined the way the various aspects of teacher knowledge required for teaching design and technology can be covered in open and distance learning courses. The audio-visual case studies, the academic materials and the practical activity can all be investigated at home. However, student-teachers are not completely isolated on Open University courses. All courses have an element of face-to-face tutorial provision which are increasingly being supplemented by contacts made using computer conferencing. In the courses considered here, the students are given a number of opportunities to meet and discuss their use of the materials and classroom strategies for teaching design and technology. Open and distance learning is a cost-effective way of supplementing conventional tuition which enables student-teachers to work at times and locations convenient to them and which impacts to a limited extent on their professional and personal lives. Such courses have much to offer in the daunting in-service education task facing us in the implementation of high quality technology education into elementary schools.

(A picture is missing here. “Picture: “The problem of the Two Eggs“)

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A survey of the effectiveness of in-service courses for teachers of primary school design and technology in England

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Introduction

In 1990, a new national curriculum for design and technology for primary children was introduced into all state schools in England. Although primary teachers had always taught science and art and craft together with a range of related subjects, design and technology was a new, single subject. It soon became apparent that the nature of the subject needed further understanding before it could be taught effectively in schools. Inservice training for primary teachers of design and technology, however, has been provided in an inconsistent way and it was not until 1993 that extended courses became available through government funded Grants for Educational Support and Training (GEST) courses. The courses were originally funded for twenty days but since 1994 have varied in length from five to twenty days.

The growth of the courses was rapid but no formal evaluation has been set up nationally to match the comprehensive study undertaken for similar courses for mathematics and science (Harland and Kinder, 1992). In April 1994, a conference was held at Warwick University to review the first set of GEST funded courses held throughout the country, and the findings were reported in the conference proceedings. It became evident that a broader evaluation was required to identify the key areas that were proving successful and those that needed development. This paper forms a part of that evaluative process by describing a survey which was carried out into the degree of change generated by four courses run at The University of Central England and Warwick University.

Brief Description of the Four Courses

The courses at UCE were both 16 days in duration and at Warwick University the 20-day course was followed the next year by a shortened 6- day course. At both institutions, certain key elements were a necessary requirement for validation by the Department for Education (DfE), and were therefore included in all courses. These included the development of teachers' own knowledge and understanding of design and technology and their ability to plan and implement design and technology in school. Courses were to be jointly planned by Local Education Authority (LEA) and universities. Within this framework, the aims, objectives and content of the courses at the two institutions varied somewhat.

The courses at Warwick University placed a high emphasis on enhancing teachers' understanding of the nature of design and technology, and exploring the inherent processes through work with children, as a structured part of the course. Aspects of knowledge and understanding were developed through workshops where teachers sampled a range of activities.

Within the UCE. courses there was, in contrast, a greater emphasis on developing knowledge and understanding, whilst enhancing teachers' practical capability and making teaching aids which could be taken back to school. In addition, this course included 6 days delivered by LEA staff, where teachers worked on a long task at their own level. Here the emphasis was on making a high quality product. Courses at both universities explored issues relating to the role of the primary school co-ordinator for design and technology.

Survey intentions

It is important to be clear about the intentions of the survey and to recognise its limitations. The main aim of the survey was to gather information on the perceived changes within each school as a result of the courses attended. Some schools, which were already doing well in this subject, therefore, may have witnessed relatively small improvements. Generally, however, course members were chosen to attend the courses because the school had identified a need for improvement within the subject.

The first part of the survey focused on three main areas of potential change. Respondents were asked about the perceived change in themselves as course members, some of the staff at their school and, finally, the whole school staff. Due to the inherent difficulties in gauging the change that an in-service course makes within a school, it was recognised that the analysis of the results should involve looking at general trends rather than individual results.

Methodology

The survey was carried out by using a questionnaire sent through the postal system to all members of the four courses described above. It was felt that this had a number of advantages. It gave respondents the chance to consider their own answers without being unduly influenced by those who had run the courses themselves. It was one of the least time-consuming options as far as the course members were concerned. It made it easy for teachers not to participate if they so wished. In this respect the survey responses will reflect the views of those who were interested enough to reply to the questionnaire.

The questionnaire made considerable use of a simple numeric scale in order to gauge the degree of change in any one area. This was as follows:

Ring one number changed a lot .... no change
1 2 3 4 5

The results were added to show the total number of responses for each number on the scale, thus indicating a trend towards a greater or lesser degree of change.

The questions were arranged around 4 main areas of interest:

1. Teachers' background knowledge of design and technology and the conceptual knowledge which supports this.
2. Dissemination of ideas from the courses and support provided in school for design and technology
3. The parts of the course which had significant effects on the participants.
4. The effect of the course on the whole school.

An initial questionnaire was drawn up and trialed with four of the teachers, each of whom had attended one of the four courses. This was followed up with individual interviews to gather information on how to improve the questions and the format of the questionnaire. The questionnaire, in its final form, was posted to all course members with a copy to their head teachers with a deadline of two weeks in which to respond.

The survey technique had a number of limitations:

- Respondents had a personal interest in indicating a significant degree of change since they were the main agents of such change.
- Degree of change in understanding, attitude and approach to a curriculum area was measured subjectively through the views of a single person.
- Some changes in schools would have happened without the influence of the in-service course. It is impossible to separate all such influences.

Survey Results and Analysis

Out of a potential 71 course members there were 25 respondents split almost equally between those attending courses in each of the two universities. Respondents did not answer all the questions since, in some instances; these were not all relevant to their particular course. It was noticed, in a significant number of cases, that the distribution of responses for the participants at both universities were similar so it was decided to combine both sets of results and focus on the general patterns which emerged from these.

Teachers' Background Knowledge and Understanding in Design and Technology

Respondents were asked about their own understanding, and that of their colleagues, of the processes of design and technology and their ability to use tools, materials and processes associated with these. They were asked to comment on their increased ability to plan, implement and assess design and technology. Also a large part of this section focused on the following areas of knowledge and understanding: structures and forces, mechanisms, control, energy, food and textiles.

A general trend in this section was for a significant increase in ability to be indicated for the course members but a lesser change for some of their colleagues in the school. An even smaller change was recorded in every case for the whole staff in the school. This trend is indicated in Fig. 1 which shows the results for an understanding of Structures and Forces and in Fig 2. for Control (Appendix).

Fig 1 shows there was a firm consensus of opinion as to the degree of change for each of the three groups while Fig. 2 shows less of a consensus. This may have been because Control as a distinct area of study did not feature so strongly on each of the four courses. Structures, however, was almost certainly a key area of study making a more significant impact.

If results are compared for all subject knowledge areas then course members felt they had improved their understanding of Mechanisms the most, followed closely by Structures. The least change for course members was indicated in Textiles followed by Food technology. A similar pattern was noticed for *some colleagues in schools*. This general trend may have been because of a general emphasis within the courses on subject knowledge which is less familiar to primary school teachers such as those associated with the physical sciences. Indeed the specifications, set out by the funding body for the GEST funded courses, included mention of Structures and Mechanisms while not requesting, directly, work in Food and Textiles. A pre-course audit at UCE found that prospective course members felt they had a degree of confidence in Textiles and Food, thus supporting the theory that less change might be expected in this area.

The responses to the question about practical capability – an ability to handle tools and materials – showed an apparent lack of confidence in some respondents. 29% of respondents felt that they had made little or no change in this area, while the same percentage felt a moderate change had occurred. This may have been because they already possessed a degree of capability or that they did not recognize the need to achieve a practical capability themselves. It is more likely, however, that a practical ability is not easily gained on a relatively short course when much of the focus is on knowledge and understanding and issues such as classroom management.

The greatest increase in understanding, overall, was reserved for understanding of the processes of designing and making. Here 76% of respondents indicated they had changed a lot or quite a lot in their understanding. The results show that much of this understanding had been passed on to colleagues in school too. Such large improvements in a fundamental understanding of the subject indicate how relatively new these ideas are to most primary teachers and how much still has to be done to increase an overall understanding in all schools in England.

Dissemination of Ideas From the Courses and Support Provided in School for Design and Technology

Teachers were asked how ideas gained on the courses had been disseminated within their own school. The data revealed that informal discussion played the largest role in dissemination, with almost all teachers having been involved in discussion with colleagues through after-school meetings. Relatively few course members had been able to share ideas through subsequent in-school training days. As English schools have only5 such days each year and design and technology is not a core curriculum subject this is perhaps not surprising. Only one-third of teachers reported having any non-contact time for developing design and technology within their school. Where this had been available, either on a regular basis or as several whole days, it had been spent on a variety of tasks including writing schemes of work and meeting colleagues. Almost all teachers had used written materials to pass on ideas to colleagues and about one-third had worked alongside other teachers in their classrooms. One teacher commented that although time for formal dissemination was limited, the ideas had been transmitted through writing the school policy.

Funding for design and technology has been shown to vary across the country (DATA, 1995) and the survey showed that only one-third of schools had allocated extra funds to design technology as a result of the course. Some teachers reported other spending priorities, such as for Information Technology, or that each curriculum area is part of a rota for focused funding. If new ideas from a course are to be disseminated effectively then a temporary boost to funding would seem advantageous, as a time-lag in the availability of equipment to implement new ideas might mean they are not taken up effectively once initial enthusiasm has waned.

The Most Significant Effects of Elements of the Courses on Schools

The course members were asked to identify three key aspects of the course which they felt had the most influence on the teaching of design and technology in their schools. Overall, there was a significant difference in the response from teachers on courses at different institutions. At UCE over 70% of teachers identified knowledge and understanding (particularly in the areas of Textiles, Food and Mechanisms), linked to practical capability, as having had the most influence, whilst at Warwick University the pattern was very different. The responses here showed that there was no one aspect that had had a major influence. Indeed there was a wide variety of aspects which were identified and each influenced a small percentage of the teachers. This pattern could be explained by the nature of the courses at the different institutions.

Two further points of particular interest emerged from the data analysis. Whilst Food and Textiles were identified at UCE as having had the most influence and were chosen as the most influential areas in the course evaluations, they were not identified as having brought about a significant change in terms of the knowledge and understanding of the teachers. This can be explained in two ways. The teachers may have gained ideas for practical implementation rather than increased knowledge and understanding and the ”feel good factor” of the day may have remained with them, making it difficult to distinguish between enjoyment and influence on teaching. Secondly, although Structures and Forces were identified as areas in which teachers’ knowledge and understanding had increased the most, they were not identified as having had a great influence on teaching in school. This could be explained by the fact that the course may have increased the teachers knowledge and understanding but, as Structures is a topic that is covered less frequently, it has not yet had an impact on teaching.

Overview of the Effects of the Whole Course on the Schools

Information was gathered relating to the place of design and technology in the school development plan, including the development of a school policy for design and technology and schemes of work. The perceived influence of the course on the head teacher’s attitude towards the teaching of design and technology was also examined. An analysis of the survey responses shows that, overall, the participation in all of the courses has had a positive effect on schools, though this has not occurred uniformly in all schools. The majority of schools have linked the courses with the school development plan and this was one criterion for entry onto the course.

There were differences between courses at the different institutions on the issue of the degree to which the head teacher had been influenced with regard to the teaching of design and technology in school. Whilst on the Warwick courses it was felt that 70% of head teachers had been influenced a lot or quite a lot by the courses, only 43 % of teachers on the courses at UCE identified that the head teachers had been significantly influenced since the course. On the Warwick courses, unlike those at UCE, the head teachers were involved at key times during each courses. They attended an initial meeting to discuss the nature of the course and the intended outcomes and visits were made to some of the schools during the courses. Most significantly, the head teachers attended the final session of each course in order to discuss the needs of their school with the course member and to agree an action plan for the future.

Conclusions

The conclusions drawn from the results of the survey are:

- The courses surveyed have been shown to make changes in the perceived understanding of course members, and their colleagues in schools to varying degrees. In some areas of knowledge and understanding there has been more change than in others.
- One area of greatest improvement as a result of the courses was in an understanding of the processes of designing and making, thus indicating a probable lack of understanding before the courses.
- A greater change can be detected in those areas which were specified by the course funding body. (Structures, mechanisms etc).
- The degree of change is related to previous knowledge, confidence and perception of participant as well as course content.
- The different nature of some of the courses provides some reasons for different course members' perceptions of change.
- The cascade effect whereby course members pass on the knowledge and understanding gained on a course to their colleagues in schools can be measured to some degree. This effect, however, appears to diminish when all the members of staff in a school are considered.
- Dissemination of ideas gained on a course takes place largely through informal conversations, staff meetings and written materials, but could be improved by employing a wider range of methods.
- The time to disseminate ideas is not always made available tore turning course members.
- Additional funds to support the dissemination of ideas gained on a course are not always made available at the most effective time after a course.
- There is room for improvement in the way head teachers are positively influenced by the courses their staff attend. The link between course aims and head teacher's perceptions of course are important.

Recommendations

In the light of the conclusions above, the authors would recommend the following for future in-service courses in design and technology.

1. Those who fund courses should identify a limited number of aspects which should be focused on by the course providers.
2. Course providers should include, as part of the course, ways in which course participants might disseminate new ideas to colleagues when they return to school.
3. Schools, including the head teacher, should do more to support the dissemination of course ideas and there should be a greater variety of ways in which this is achieved.
4. Head teachers should be made more aware of the details of the course and how they might support change within their school as a result of the course.

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Clare Benson, Rob Johnsey, Di Wiggins March 1996.

Appendix
Fig 1. Knowledge and understanding of Structures and Forces

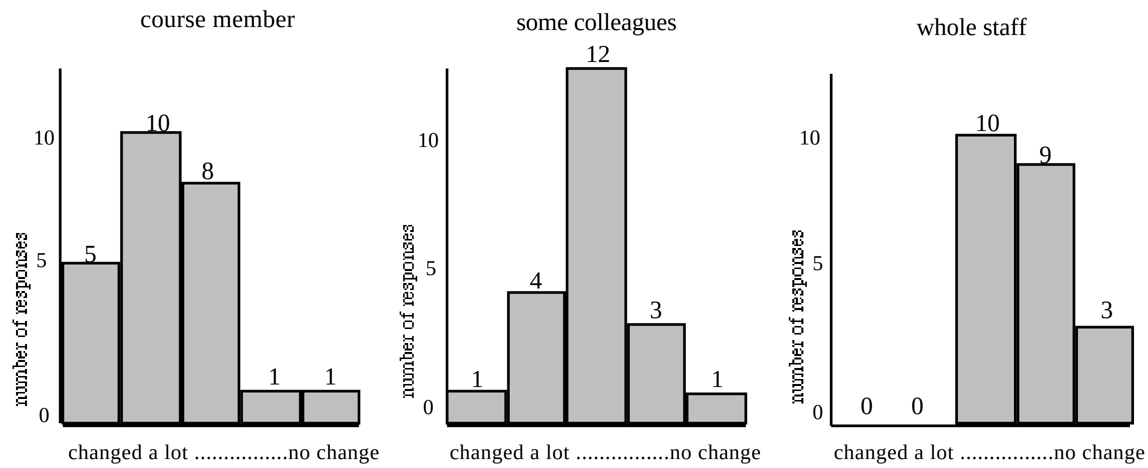
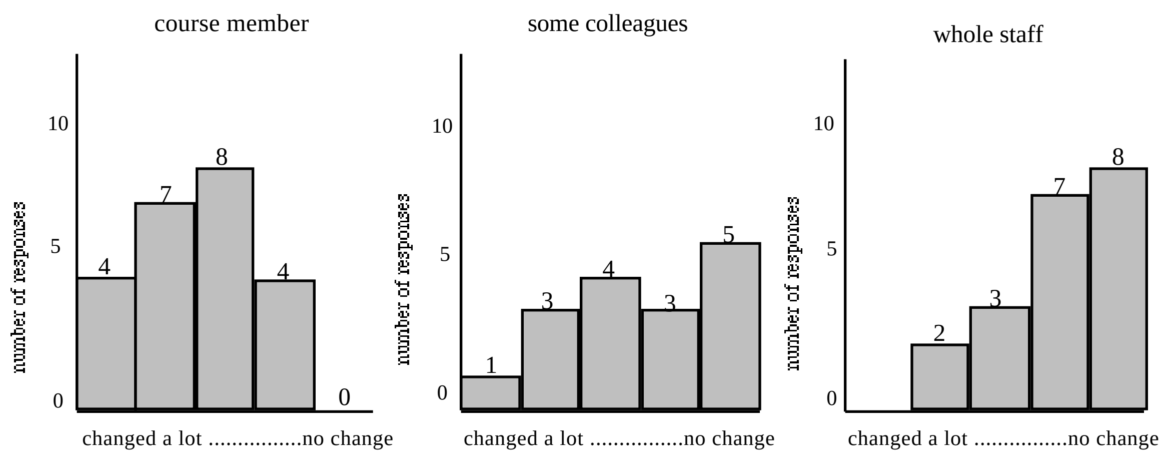


Fig 2. Knowledge and understanding of Control



A Comparison of Two English Primary Schools in Their Consideration of Progression in Design And Technology Education

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Introduction

Design and Technology has been a compulsory foundation subject in the National Curriculum for England and Wales since 1991. At that time its introduction created a high amount of anxiety amongst teachers in primary schools relating to personal subject knowledge, understanding of a complex holistic process and classroom implementation, these observations being based upon discussions made with colleagues from across the Local Education Authority in which this paper is based.

This paper contains a series of observations made in two schools where Design and Technology is seen to demonstrate ’good practice.’ Each school shows elements of progression in various contexts and the following is an attempt to illustrate theory with practical examples showing how progression may operate at the ‘chalk-face.’

However, schools need time to implement curriculum change and the schools contained in this study are no exception. Each has invested many hours of effort in order to produce the working environment that is seen within Design and Technology today. It is with these thoughts in mind that it is necessary to include background information relating to the processes involved during the schools’ development since the initial introduction of Design and Technology as a National Curriculum subject.

Background

In response to the need mentioned in the introduction the Local Education Authority (LEA), in which the two study schools are situated, organized acomprehensive series of In Service courses, the outcome of which resulted in raising awareness, expertise and confidence of teachers in the area, and, enabling Design and Technology to become firmly established within the primary curriculum. Part of an empty school was used as a base for the courses, housing a seconded primary teacher who assumed the role of 'Advisory Teacher for Design and Technology' and an overall coordinator. The centre itself was well equipped with a full range of resources suitable for use in both the primary and secondary phases of school. It became an extremely valuable and well used resource for the LEA and one in which visiting groups were able to practice their skills, gain advice and research classroom ideas in comfortable surroundings. Additional support came from a team of teachers who worked on a part-time basis to tutor courses, each member utilising their specific area of expertise. This innovation enabled the majority to gain greater access to the subject, rather than let it remain the domain of the minority of 'specialist' or 'enthusiastic' teachers.

After this intensive period of in-service work many schools, including those in this study, began their own staff development in the subject and laid the ground rules for the future, and the response of one school to this is described later.

Subsequently however, the statutory order has undergone further revision and streamlining resulting in schools having to reassess and revise their policy and practice to some extent, taking into account changes in the status of Design and Technology as a subject in the primary curriculum, assessment procedures and implementation of the new documentation, having only recently become familiar with the 'old' layout of four 'Attainment Targets' covering the design process. (D.E.S., 1990). The current order was introduced in September 1995 and contained anumber of fundamental changes, which I believe, were generally welcomed by the teaching profession. The emphasis on the process approach, whilst still in evidence, was less obvious and reference to specific areas of concepts, skills and knowledge took a higher priority. Briefly the structure of the current order covers three main areas, those of Designing, Making and Knowledge and Understanding. Each is then further subdivided into generalised statements that inform the type of work children are to undertake and which teachers relate to their planning. Systematic assessment is seen to be an integral part of the process and both Designing and Making have hierarchical statements of attainment, termed 'level descriptions' which are used to determine an individuals progress in each area. Types of activity have been introduced to enhance capability and include 'Design and Make Assignments', where the children work through the design process, 'Focused Practical Tasks' where the teacher identifies specific skills and techniques to extend the children's expertise, and in which there are implications for progression that will be discussed later in this paper, and activities where products are evaluated and disassembled in order to assess their suitability for given tasks. (D.f.E.E 1995) In primary schools the National curriculum covers Key Stage 1 (4–7 years) and Key Stage 2 (7–11 years).

It is against this background of rapid curriculum change that both schools have had to readdress and in some instances radically revise their approach to Design and Technology so that effective progression is catered for.

The Schools

The schools are situated in the North East of England in the towns of Middlesbrough (School A) and Stockton (School B) respectively. In addition to geographical proximity they demonstrate further similarities in terms of size, (400 approx.), catchment areas and general ethos, relying heavily on child centred experiential approaches. The schools also have nurseries attached to them and the children from here generally progress from there to the main school. The level of expertise and enthusiasm for Design and Technology generally is high in each, the basis for this being directly related to the initial LEA teacher In Service training described earlier, and the extensive periods of in school development that took place additionally.

To expand on this background further there follows a description of the intensive period of staff development School A undertook to run concurrently with the introduction of the original document. Previously, there was some evidence of classroom work but this was not organized i.e. scrap modelling, no progression in terms of skills taught and materials used and mainly down to individual enthusiasts.

The impending implementation of National Curriculum Technology was the catalyst and a Working Party was formed in discussion with the Headteacher. This comprised a Rate 'A' for Technology and other interested teachers from each school phase, including the IT co-ordinator. They were given aims of organising staff meetings and training days through the year in order to aid staff awareness and development and quell fears of including the subject in the curriculum, organising and purchasing resources, assessment and record keeping and writing a policy document. The Staff Development part of the programme was extensive and consisted of the following:

1 The Working Party were given supply cover to organise the first terms' staff meetings in detail and the rest of the year in outline.

2. September:
The staff meetings began, each led by different members of the working party.

1 What is Technology?
2 Safety and Use of tools.
3 Design Process.
4 Professional Development day – a 'fun' problem solving exercise.
5 Working Environment – display, classroom organisation and resource management.
6 Resources in school and out (including places the children could visit)
7 Visit to Design Centre (insight into KS3/4)
8 Industrial speaker
9 Visit to British Steel
10 Evaluation Session

3. January:
Monthly meetings took place to provide support and feedback. In practice this was a time when teachers exchanged ideas and experiences which helped to maintain impetus and enthusiasm.

4. April:
Meetings were held to look directly at the National Curriculum (old version, including IT), record keeping, and assessment at Key Stage 1.External assessment (SATS) were introduced. The final evaluation session was used as a Professional Development Day. Throughout the programme the working party met regularly to discuss progress, make amendments and begin writing the Policy document.

The following extracts taken from the schools' Design and Technology policy documents summarise their general philosophies after this initial staff development; 'Our underlying belief is that teaching should be about preparing children for life and in a fast changing society the skills, concepts and knowledge children develop in Design and Technology should be of the kind that will have an adaptability and transferability which will be of use whatever the technology is when they leave school. To this end our aims are:

1 To develop within the children cognitive processes, skills and concepts which will have relevance to their infant and adult lives.
2 To give the children a sense of enjoyment and pride in their ability to design and make.
3 To raise children's awareness of how technology affects their lives, and how they might effect change themselves.
4 To develop within the children the development of personal qualities such as perseverance, a willingness to lead or follow as the occasion demands, and a willingness to listen and consider the ideas of others.
5 To encourage within the children the development of communication skills both verbal and non-verbal.
6 To encourage the children to value the efforts and achievements of others.
7 To develop within the children a sense of responsibility towards tools, equipment and their working environment e.g. tidying up!
8 To ensure that wherever possible the full range of technological activity is accessible to all children regardless of gender, race ability etc.
9 To use where possible, and appropriate the local environment as stimulus for technological activity' (School A)

'Our aim is for the children to recognise the needs and opportunities for technological activity within their lives, to research and plan possible outcomes, and to realise such solutions.

Through technology children can gain a greater understanding of the world around them, learn to communicate this knowledge to others, and begin to predict and explain real life problems. As a school we see the area of technology as one which embodies the elements of Craft, Design and Technology, Art, Food studies, Business Studies and Information Technology. Where possible experiences within technology will be developed through cross-curricular themes and topics. Our whole school policy allows for progression and continuity of work, but still takes into account the need for individual investigation and for each child to work at their own particular level.' (School B)

Since that time there has been the opportunity for the schools to use the firm foundations they had created to put into place and consolidate their way of working in Design and Technology, despite having to adapt to changing external circumstances with the revision of the National Curriculum. It is from this background that the progression and continuity within the subject can be viewed at this point in time.

Progression in Practice.

As will be further illustrated, evidence of progression within the school scan be viewed from various standpoints, being related directly and indirectly to the subject area. An example of this would be an examination of progression of capability where aspects of Design and Technology are related to methods of evaluating the rest of the curriculum, such as assessment, or planning, where similar methods are used, but referring to different content.

As an overview, the National Curriculum Orders through the Programmes of Study and Level Descriptions are structured in such a way that a progression can be seen, but insufficient detail requires teachers to seek further guidance and create individual responses for their own situation. However, this assumes that children learn in a linear fashion, and, particularly in a subject such as Design and Technology where a cyclical process is involved, this would seem to be unrealistic, as if progression is seen to be advancement in successive steps, individuals will require different successive steps to make progress. This would necessitate the intervention of teachers to move children forward, building upon their existing skills and knowledge and understanding, and consolidating and revisiting more basic ideas when appropriate (Ritchie, 1995).

This issue was identified by both schools as being fundamental to being able to put their policy into practice and they felt that an assessment of the childs starting point would be needed in order to inform the teacher of the most logical way in which to proceed and how much support would be required. The implication here being that differentiation of activities may be needed and an effective means of recording individual progress so that experiences could be built upon in a structured way.

So, an efficient record – keeping system would seem to be one way of tracking progress. This is an example of how wider school issues relate indirectly to Design and Technology, each school using their whole school policy for assessment and record keeping as a basis.

Both schools have formulated different, but equally effective approaches. Assessment is seen to be both a whole school, and an ongoing, process with every teacher involved, not just those teaching end of Key Stage classes when external assessment takes place. In School B each child has a booklet containing the full set of National Curriculum level descriptions. In Design and Technology, teachers aim to observe and talk with each child half termly and record their progress by indicating which level descriptor statement they have achieved. Teachers attempt to build into their planning suitable times when such intervention is possible, as, with classes of 30+ pupils in some cases, individual attention is not easy to monitor. However, this is an example where the benefits of several years' development of

Design and Technology shows, with the teachers feeling enhanced confidence, and the children being the recipients of a consistent approach since their Early Years of schooling. This profile gradually builds up over the childs time in school. It acts as a clearly visible record of areas that may need support or extension, and substantiated by comments as to the type of evidence against which the judgements are made, is a rigorous method of allowing teachers to see where progress is /is not being, made.

In School A the system is slightly different, but equally effective for them. Here each child has a Design and Technology folder which contains evidence of their work over their years in school. Each piece, (written, pictorial or photographic) is supported by an explanation of the context in which the work took place and the specific part of the National Curriculum to which it refers. The folder is intended as a profile to show the childs achievements and in order to keep the system manageable contains one or two pieces of evidence per year. As much of the work in the early and middle years is done collaboratively the upper years of the school (years 5 and 6) include additional evidence which incorporate more formal assessment of a specific individual design and make task in which the children are given autonomy over what it is they wish to produce from within their current theme. They are encouraged to work through the design process with minimal support from the teacher. This opportunity is used to record observations against National curriculum criteria. The system was adopted before the National Curriculum revision and is an example of how a school has had to quite radically, and quickly; change their approach from one set of documents to another. With Curriculum revision being on the agenda, during an INSET day the school took the opportunity to simplify National Curriculum level descriptors into language that could be clearly understood by all members of staff, and, in their opinion make the task of matching level to individual performance easier.

Below is an example comparing the National Curriculum Level Description, Level 4, Designing, and the individual version favoured by the school.

‘When designing and making, pupils gather information independently, and use it to help generate a number of ideas. They recognise that users have views and preferences, and are beginning to take them into account. They evaluate their work as it develops, bearing in mind the purposes for which it was intended. They illustrate alternatives using sketches and models and make choices between them, showing an awareness of constraints’ (DfEE1995)

‘Pupils draw from a range of sources to help with their designing e.g. research storybooks prior to making one, use reference materials and artefacts. They have a developing awareness of constraints e.g. economy, time, materials. They suggest more than one idea and make choices considering constraints.(School A)

Teachers therefore have concrete guidelines on which to base their own observations.

Closely linked to assessment and recording is planning, with the former being used to inform the latter, and vice versa. Again, whole school policy indirectly influences progression in the subject.

Both schools have adopted a similar framework for planning their curriculum.

A three tier model of long, medium and short term planning is favoured which is centred around the topic-based approach where a central theme is used as the focus from which the individual subject content radiates. The topic themes are discussed and decided upon well in advance, during whole school planning meetings, to ensure that teachers feel part of, or own the process. Both schools use a two year rolling programme of themes to accommodate the idiosyncrasies of classes that are vertically grouped i.e. contain children of different year groups. Medium term planning occurs three times a year and involves teams of teachers who work in similar age ranges, namely, Early Years (Reception, Year 1 and 2), Middle (Years 3 and 4) and Upper (Years 5 and 6). Each teacher within the term plans for a different curriculum area and this is disseminated to the remainder of the group. Within Design and Technology categories covered during planning would include National Curriculum links, type of activity, including specific skill or material focus, teaching strategies, type of activity, resources, broad learning outcomes, assessment opportunities and cross – curricular links.

Short term planning is undertaken by the individual class teacher and puts into a manageable sequence the activities planned by the team so that they may be taught effectively in the classroom. Included in such planning would be intended learning outcomes and assessment opportunities for a specific lesson and ways in which the task may be differentiated according to the needs of the individuals in the group.

Effective and realistic planning is seen by both schools to be one of the strategies used to ensure that progression takes place and one (school A)has developed a framework that sets out to categorise a range of skills relating to different materials that they feel are applicable to their situation, covering construction, joining and combining and finishing. The same framework would not necessarily work in a different establishment as it has been produced with their topics and resources in mind. Overleaf is an example of one area covered by the framework:

Joining and Combining

Level:	1	2	3	4	5
Material Wood	Glue gun (Teacher)	Tri-corners Nailing (Wood) Screw Nuts & Bolts (Meccano)	Nuts & bolts (Child)	Glue gun	Mitred joint
Card and Paper	Pipe cleaner Pritt stick P.V.A	Paper clip Paper fastener Art straw Hinge	Slot and flap		
Fabrics and Yarns	Pritt stick	Begin to use needle and thread Running, blanket and cross stitch		Use needle and thread independently Button, press studs Velcro.	
Plastics	Glue gun (teacher) Sellotape	Dowelling (corriflute)		Glue gun (Child) Frame of wood for corriflute	
Food	Mixing wet and dry ingredients	Introduce correct language		Techniques i.e. beating folding	Reasons i.e. air

As the above extract illustrates, it gives teachers a broad outline of whereto start their planning knowing the type of experiences children should previously have acquired, but it is merely intended as a minimum for the types of technique the children should experience.

Issues directly related to Design and Technology, such as classroom and resource management, have, by the very nature of the systems employed be seen to demonstrate what could be termed ‘built-in’ progression. In order for children to become independent whilst working, great emphasis has been placed on efficient means of storing and organizing resources so that children have clear messages about what is available. The issue of resourcing has been tackled in different ways by both schools, but with the common aim of enabling children to work as autonomously as possible. For this to be achieved it is necessary for a whole school approach for resourcing to be adopted so that the children are familiar, from an early age, with what materials/ resources are available to them and how they may gain access.

Individual teachers in School A organise consumable resources that the children have free access to in various containers that enable the children to explore and manipulate them during their design and make tasks. The staff adopt a system for the storage of tools where they are placed against a silhouette background; the children knowing straightaway if one is missing. Progression is ‘built in’ with the distribution of tools for resistant materials, as in the Early Years only small a selection are available which gradually increase with competence.

Some non-consumable and expensive resources are more tightly controlled and are kept in a central resource area. Staff are able to collect the items that are needed before beginning work.

The school is well equipped with construction materials and the children are encouraged to use these during their projects. Progression is again ‘built in’ as the kits are arranged through the school so that the children experience increasingly complex systems as they progress. For example:

Distribution of Construction Kits to Illustrate Progression of Experience.

Year Group:	N*	R*	Y 1,2*	Y 3	Y4	Y 5	Y6
Type of Kit							
Balance	Blocks -------->---------						
Push/Fix	Stickle---------->---------						
	Mobilo			Reo Click------>----			
	Duplo		Lego------------>------------------->--------------->-------------->				
				Technic (mechanical)---->----(motors)-------->--			
						Technic (control)--	
Bolt/screw			Brio-tech		Multibuild)------>--------------->---------------------		
				Meccano)			

*(N= nursery, R=reception, Y= year group)

Construction kits are seen as an important part of the children’s technological experience, and the above shows how School A is able to increase dexterity and expertise whilst maintaining interest and enthusiasm as different kits are introduced as the individual moves into a new year group.

School B operates a similar system of organisation, particularly in terms of control technology, which is an area the children look forward to using in Years 5 & 6. Work with construction is planned in with other Design and Technology activities, and children are encouraged to use parts of kits to support other aspects of their making.

In addition, School B uses a whole school approach to resources where by children use a ‘traffic light’ system for materials, green indicating free access, amber indicating use some, and red requiring the child to ask permission. However, the children are aware of how the system operates and of what is available to them and this encourages the independent learner from a young age. Progression is again ‘built-in’ as teachers only give the children access to the materials and resources they have decide dare suitable for them to use. Safety being an important issue for consideration.

The above have important effects on planning for progression and both schools recognise the importance of providing children with first hand experiences that encourage them to work in an increasingly autonomous way.

To facilitate this, both schools have designated Design and Technology areas within each classroom. These are not purpose built and it is up to the ingenuity of the individual teacher to create a suitable working environment. Such areas tend to follow certain criteria and may take the form of a corner of the classroom that gives adequate light, has an uninterrupted line of sight and has minimal potential for other children not engaged in Design and Technology activities to walk by and possibly disrupt. Quality environments are generally created so that children want to work in them, so attention is given to the 'design messages' that are displayed, e.g. children's work effectively arranged, examples of relevant literature, neat and tidy graphics and labelling, posters showing types of 'technology' and artefacts to explore, investigate and disassemble. School B and the Nursery of school A also have specialist areas for food technology, access to which is timetabled.

Introducing the children to the work they are to cover varies according to the organisation of the age range. For example, each school operates an integrated day approach in Early and Key Stage 1 classes, and so Design and Technology is undertaken as a small group, teacher intensive activity initially and with auxiliary support later. The amount of support varies according to the nature of the task.

During Key Stage 2, School A favours introducing new Design and Technology topics to the whole group, after which the children are able to complete their design work, and begin making in smaller groups as the timetable allows. The teacher intervenes as is necessary, but does not work in close contact.

School B operates in a similar mode, but there is a greater emphasis on children working independently, knowing their tasks for the day and completing them in their own time. The status given to Design and Technology in this school makes it a high priority subject in the perception of the children and they generally stay on task and work competently. The teacher is then free to offer help and support wherever necessary.

Each school has recognised the need for teaching specific skills and techniques. As previously explained, School A uses a framework of basic skills that are taught at different levels. This however, is operated flexibly so as not to stifle individual creativity, and a skill would be introduced if an individual needed the knowledge to complete a piece of work.

School B plan specific teaching points into individual topic planning, which at present works well, due to the amount of technological work being undertaken, but does have the disadvantage of being potentially hit and miss in its coverage, this being an area for future development.

The National Curriculum describes the need for Focused Practical Tasks in the revised orders and it is particularly interesting that a semi-structured approach to skills acquisition had been previously recognised by each school in order to produce enhanced capability in their pupils.

Concluding Remarks

This paper has attempted to document individualistic approaches to progression in Design and Technology. Neither school assumes to have solved all the issues comprehensively, and recognise the need for on-going development, but they do illustrate different ways in which it is possible to provide children with structured experiences during their time in primary school.

It would seem that there are common areas that require attention for the above to begin to take place, namely:

1. A supportive and enthusiastic staff who are willing to uphold whole school issues and work towards common policies.
2. A staff who view Design and Technology positively and understand the need for its inclusion in the curriculum
3. Effective assessment, recording and reporting strategies.
4. Collaborative and realistic methods of planning.
5. Efficient, easily managed and structured approaches to resource and classroom management.
6. Time, and money, to put the above into practice!

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Technology Education in Primary Education in the Netherlands: How Do We Realise This?

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Everyone in every place has to deal with technology. Technology is part of daily life. If education tries to teach pupils and students how to live in a modern society, then it has to teach pupils and students to deal with technology. So it has to be a part of compulsory education, also of primary education. In my presentation at the PATT- 7 conference in Breukelen, last year april, I presented the results of a short questionary I had asked teachers in primary schools. The general conclusion was that all the teachers liked to give technology education a greater place in their lessons, but they didn't know how to do it.

I. Publication of an Action Plan

In 1993 the Netherlands government published an action plan to give technology a place in Dutch primary schools. The actions should result in implementation of technology education in primary schools.

In the Netherlands the primary school curriculum is overloaded. Therefore the choice has been made to integrate technology in existing subjects, especially in the subjects science (in Dutch: 'natuur' = in German 'Natur' like in 'Naturwissenschaften', in Dutch 'natuurwetenschappen') and in craft. (The outcomes of the questionary pointed in the same direction. Dutch teachers made a choice for implementation in craft and nature education.) The plan also gives a description of the possibilities of technology activities out of school, in clubs, museums and so called 'discovery places'.

II. Three lines to get more technology in and around primary education

In order to try to get more attention towards technology in primary education, three main lines have been described along which the stimulation of technology education must take place. These lines are:

a. to develop methods and material,
b. to react on action that takes place around the primary schools,
c. to teach the new teachers.

Let us have a closer look at these lines:

II a. To Develop Methods and Materials

The National Institute for Curriculum Development (the SLO) was asked to develop a curriculum, in which technology was incorporated in the present school curriculum. It must be incorporated in existing subjects, because the school program is overloaded. If technology gets a real chance, then it must not be a new part of the school curriculum.

Other support institutes were asked to develop lessons as part of this integrated curriculum, so it could be easy for the Netherlands teachers to implement technology education in their own program.

II b. To React on Action That Takes Place Around the Primary Schools

Outside the school there are a lot of possibilities to practice technology. You can think about training centers in firms, technology clubs and museums. There are more possibilities that schools can use. That is why this kind of projects is supported financially, so schools can participate in networks, which give technology a greater chance in schools.

II c. To Teach the New Teachers

If technology is a part of the training of new teachers, then the new teachers should come into the schools with knowledge about technology and technology education.

That makes an acceptance of technology education in schools more easier. At this moment 8 schools for teacher training have already plans for developing new lessons and materials which can be used in teacher education, but also in primary schools. The government also gives the teacher training colleges a substantial amount of money to equip a technology classroom, where future teachers and primary school classes can visit and play with technology.

III. Philosophy of the Steering Group

The action plan on technology had a great response in the Netherlands. Both schools and teacher education institutes made clear that they would support this plan. To realise and to coordinate this plan a committee was formed under the name Steering group for technology in primary education. This committee that will exist for 5 years, described what they will use as the working definition of technology education[1].

III a. Working Definition of Technology

Technology is a field of human activities, based on collections; knowledge and skills, by wich humans provide themselves with the means to adapt the environment to their needs, both in their own interest and in the interest of the group.

In technology and in primary technology education there are 5 aspects, which are very important:

1. The process of technology is central. It must be clear that technology is developing, making and using of materials. It is not about the products but about the process of developing these products.
2. The knowledge of technical principals. We must teach the pupils about the technical principles like movement, information etc.
3. Technology has a historical component. Technology is a part of human activities with a history and a future.
4. Technology and society. Technology has changed the lifes of the pupils and pupils must get a positive attitude towards technology. Technology has an impact on how society is organized. It infuences profoundly the life of pupils. They must learn to be aware of this influence and develop a critical attitude towards benefits and risks of technology.
5. Materials, energy and information. Recently the accent in technology was

shifted from material technology towards energy-technology and information-technology.

IV. Projects of the Steering Group

The main activity was to start a project that would give a lot of schools (1500 from the 8000 schools for primary education) course material and equipment. There were 15 projects chosen to be presented to the schools. The schools could make their choice and in January 1996 they received the material and the lessons.

Before I come to a description of a project, lets have a look at **the aim of the project**:

Teachers and pupils get acquainted with technology and have experiments in all the age groups. The experience they have, must give a positive impression to the teachers and their pupils, so they will look to other possibilities of technology education.

The project consists of four stages:

Stage 1: Between January and September 1995.
The Steering group selected the projects to be presented to the schools. Publicity was made and the support services for school were asked if they would help the evaluation.

Stage 2: Between September and December 1995.
The projects are presented to the schools in a small booklet and schools make their choices. When all the choices are made, the Steering group divides the projects among the schools and let the schools know what project they can expect. The school-support services receive all the material, so they can make preparations for the advice and the evaluation.

Stage 3: Between January and May 1996.
This is the most important stage. In this stage all the selected schools get their projects and now it is time to get experienced in technology education. The teachers and the pupils deal with the project in the school, make experiments and learn to know about technology education in the classroom.

Stage 4: Between May and September 1996.
In this stage the evaluation will take place. At the moment of writing of this paper, the Steering Group just presented their first proposal of the evaluation. It was their

idea to hold interviews with all the schools that worked with the projects.

The school-support services disagreed with this way of evaluation. Although they agree with the Steering Group that this is the best way of evaluation, this was not the way they would do it. It costs a lot of time for the services as well as to the schools and yet it is not clear what will happen with the outcome of the interviews. So they told the Steering Group that an evaluation on paper is the one they would prefer. At this moment (March 1996) it is not clear in what way the evaluation will take place.

V. What Makes a Technology Project a School Technology Project?

You can take a technology project at will, but then you are not sure the project will fit in the classroom and teacher and pupils enjoy experimenting with it, although the project in itself is a good project. So the Steering group made up their minds and wrote down 7 points of selection, before a project was to presented to schools. Here are the points:

1. It has to be usable in normal classes, without any changes, extra material etc.
2. The project must be developed for a special age group.
3. It must be have been used in classes before.
4. It must not be necessary to get extra provisions in schools, before working with the project.
5. It is not necessary for the teacher to get some extra education, before working with the project.
6. It must have a relation with the curriculum the National Institute for Curriculum Development has developed, as I
7. mentioned earlier.
8. The project asks about 10 to15 hours of education.

As you see, the Steering group tries to find projects, that are very easy to work with in schools. The philosophy behind all this is, when you give teachers and pupils some projects that are easy to deal with, they might get some enthusiasm about technology education and try to find more projects for their schools, and that was the main part of the aim of the project as I described earlier.

VI. Projects for Schools

Now I will describe three projects, presented to schools and chosen by schools:

VI a. A Small Course of Electronics

This project consists of a box in which all the elements are brought together. You find in the box: batteries, lamps, wires, diodes, LED's, resistances, potential meters, transistors, a hammer, a screw driver and a cutter. Beside this "electronic material" you find in the box two workbooks for the children, some books for their teachers, so they know what to do and what they will need. When the children are working with the books they will learn about:

how to make an electronic circuit with a lamp;
the effect of a resistance on the lamplight;
the effect of a potential meter on the lamplight;
making a light dimmer;
the effect of a diode on an electronic circuit;
the effect of an transistor on an electronic circuit;
building an electronic hygrometer;

The project was tested on age groups 10–12 year old girls. Working with this project gives a great pleasure, to the pupils and to the teacher. You can start immediately with the lessons and most of the experiments worked very well. The workbooks were very clear so the children could work in small groups, having fun and learning technology. I think this is a good project to get experienced in technology lessons.

VI b. Time for Technology

This project, a TECHNON publication, consists of a series of 10 technology lessons for young children, student texts, a teachers guide and a box with materials.
For many of the lessons only simple materials have to be present:
paper, glue, straws, wooden sticks.
Some titles of lessons are:

how to make a gift box,
how to make a paper monster,

a tower, made of straws,
a chair,
how to design and build a house,
how to design and make a traffic light.

The lessons have been tried out with 7–10 year old pupils. The gift box, the monster, the tower work well. The construction lessons sometimes fail because of little experience of the teachers themselves.

VI c. Steam and Steam Machines

This project consists of a series of six lessons which teach children about steam and the use of steam power in machines and technology. All the lessons follow the same schema. First is a short introduction and then the children have to do some experiments. You do the lessons in little groups or as an individual. Within the project the school gets a steam machine, a book for the teacher and a book for the pupils. With the steam machine the school gets two on steam working models of a grindstone and a circular saw.

I also tried this project out in my classroom. My experience was that the experiments were too difficult for the children, not because of what they had to do, but because of the danger. Children must use fire to make steam and to make the machine work and to get the boot moving on to the water. There was a great disappointment about the working models. When the first group and their teacher had made the steam machine working and the saw moving on, we tried to saw a Lucifer. It did not work. Even a piece of paper couldn't be sliced. Because the project about electronics was a great success, we were disappointed.

VI d. Other Projects

In this way I could describe all the 16 projects of the Steering group. You must see the projects and have a critical look at them. So I am very glad that you can see a few projects at this conference, because the publishers of the projects send them with me to show them to you. Some publishers sent me the complete project, others only send me the books for children and their teacher, but that gives you an idea as well. So you can have a look to the following projects:

1. A course of electronics
2. Batteries and lamps
3. Experiments for age groups 6 to 9
4. Time for technology
5. Lego doctor for age group 5 to 7 year
6. Steam and steam power
7. Technology with Capsela
8. Play with electricity
9. Robotica

Notes

1. We refer to the publications of Raat and de Vries *'What is technology?'* with the 5 characteristics of technology, in the Reports of PATT-1 conference 'What do girls and boys think of technology?' (Eindhoven, 1986) and of later PATT-conferences.

The Problems of New Work and New Poverty from the Perspective of School – Symptoms of a Crisis Politico-Educationally Ignored

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The following is an attempt to put symptoms and structures of the far reaching crisis of the education system of the Federal Republik of Germany in concrete terms from the viewpoint of school.

Introduction

Though the complexion of new poverty as the drawback of new work is developing into a key problem for a democratic coexistence in the Federal Republik for some time now, there are hardly any statistical studies about the temporary extent of this crisis. In particular the function of the school in socio-political discussions is very often left out. But also in the politico educational discussion there is little willingness to make a serious examination.

The public educational system moves toward the greatest crisis since1945 from the view of many teaching staffs who work in schools in so called 'social focuses'. These teachers are lamenting because they are facing the increasing problems helplessly. They observe and experience with resignation a proceeding devaluation of the standards in practice and although laws, regulations, guidelines and teaching curriculums constantly dictate updates, the question of realization remains unanswered. As a consequence of an 'old' school system which often seems hardly reform able enough and whose possibilities are restricted by the pressure to lower the expenses leading to the decline of the education in schools in 'social focuses' as the public education system moves forward to a crisis of meaning. School is already today overtaxed as an instrument of prevention against poverty in 'social focuses'. Educational offers which help to ensure future chances can hardly be provided. There are structural deficits in the social reproduction of the living in a democratic, in all are as technologised and by science influenced world. Schools in 'social focuses' could not effectively break of the reproduction of social dissimilarity and will be even less able to have an interfering effect if there is a continuation of a politico-educational line of a 'lean technological education'. The young people who did not find a way into the job market because of their bad performance in school at the end of the 70's and the beginning of the 80's, passed on their poverty and outsider position in society on to their children. In the discussion about the so-called new poverty the keyword of a two-thirds society is used. (Graphic: service parcel education)

To the Dimensions of the Crisis

The social threats in the sphere of the so-called new work have been politico-educationally known for years (and a future bound refurbishing was established in guidelines and curricula) but the practice in school lacks conceptions that can be realised with the available teachers and resources in lessons of todays school. The so-called new poverty as drawback of new work has in the meantime assumed an extent which also threatens school and confronts her with new tasks. Statistically one out of eight Germans is unemployed, one out of six German children works illegally, because child labor is cheap, in 1994 one out of seven children in the Federal Republic was directly affected by poverty. Splitting processes and erosions run through the society and are mirrored in the behavior of the children in schools (Graphic: vicious circle of disadvantage).

The current school cannot cope with the tasks assigned to her. However another school isn't available. This leads to the cardinal question if and to what extent the Federal Republic can be successful to offer a relevant general education which stands up to the need in the field of work and technology for all adolescents, because without any help at the lead-into employment there can be no democratic, well-ordered, social reproduction. If this offer is missing at the present, meaning today, the links to future developments will cease. However, just this ceasing already seems to be common in a whole lot of schools, without being considerate in the development of curricula and in the current politico educational discussion in a way that other teachers in practice of schools in the 'social focuses' would estimate it sufficient and achievable.

In the meanwhile more than thirty years of a more fundamental discussion about technological education discursive settlements and conceptions have been worked out, but the practice in schools has been only marginally reached by these efforts.

Trained teachers were not employed. The older colleagues had no other choice but to improvise with traditional conceptions. This substitute could be bared because of the energy and engagement of the colleagues in schools for over more than two decades. Even at that time it was not sufficient. The energy is now exhausted, the challenges have grown and the financial contribution for education still continues to lose attractiveness. That is why the question about credible perspectives of realization has become even more urgent, but remained without effective resonance in the education policy up to now.

The Question of Strategies – More Problems Than Answers

This dilemma is particularly voiced by teaching staffs, who have to take care of pupils in so-called social focuses (focus on social conflicts) in the big cities. Teaching curriculums don't have any real validity any more because giving a regular lesson to the pupils is hardly possible any more. It lacks staff to such an extent, that subject lessons often cannot be taught. The schools are miserably equipped (with resources). The consequence is a crisis of motivation in many of these teaching staffs. This crisis is reinforced by further politico-educationally dictated cuts in connection with new programs for which however only rarely training and further education is offered.

The place of a school as a guarantee for general education for all adolescents and for standards, that secure future chances at the social acquisition of position, seems more and more taken up by the image of a school, which children and teachers regard as a strain. Colleagues reproach the education policy and colleges for having developed logical compelling models that were prescribed to the schools without suitable instruments of realization and without leaving sufficient possibilities of correction to the schools. Teachers who are in a state of speechless isolation will hardly be able to carry out a structural school reform with commitment.

On the opposite side there are the schools in better-posed residential areas. The tendency towards privatization enters the educational system. Parental commitment compensates deficiencies by the state, private funds take a place in the organization of the school system. As staff and material lacks are covered by expenditure of the parents and by sponsoring. These schools are also attractive for industry and commerce and therefore sponsoring investment objects. The consequence is a continuous diverging of the social gap.

For some years offensive strategies have been observed in the social focuses. Because it is impossible to realize the official curriculum with the available funds, it is tried to work close to the needs. More current outlining guidelines for more self-determination (Autonomie) but with less resource- and personnel funds and an extension of the educational and care tasks of school can be named as a legitimation of this offensive line. A few schools draw this line (poster with examples can be send by airmail at interest!).

This form of education remains insufficient and also widens the social gap, but is the only sensible perspective left as long as politico-educational intervening does not take place and the line of a “lean technological education“ in connection with the privatization of payable educational contents leads to a proceeding devaluation of the public school. So while education policy and dominating representatives of the discussion in educational studies hold tight on the model of equal chances in education, the reality of the everyday school life increasingly raises doubt about this dogma.

Technology For All

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Introduction

One hundred years ago, a discussion of national academic standards for the subject areas taught in public schools would have been irrelevant. At that time, the disciplinary departmentalization by institutions of higher education validated the movement to make language arts, mathematics, science, foreign language and history essential parts of schooling. Throughout the twentieth century, these core subjects's have endured to become powerfully situated at the center of the dominant global educational paradigm.

A century later, in the current context of national education reform, educators, parents and students are questioning what students should be expected to know and be able to do through K-12 education. What should be essential education for all pupils regardless of their socio-economic background, gender or heritage?

We have developed from an agricultural to an industrial to a technological age and technology has become a predominant and influential force in our society. Today, the concepts, processes and products of technological innovation surround Americans. General technological literacy and capability are considered critical to the future of our country is businesses, government and quality of life. The study of technology is an imperative for all pupils in the next millennium.

Technology as a School Discipline

Technology education is a relatively new subject in the public school curriculum. While references to technology as a subject matter for schools can be found in U.S. education literature from the 1930s, only in the past decade has a discernible technology education movement gained momentum. Because of its newness and elusive nature as a quantifiable discipline, the study of technology is often misunderstood and confused with other structures of knowledge. In its simplest terms, technology is the study of our human created world, as contrasted to science, which is a study of our natural world.

Technology draws its intellectual domain and modes of inquiry along the dynamic continuum that starts with human wants and needs and end sin the satisfaction of those wants and needs. It includes such human capabilities as designing, inventing, innovating, practical-problem solving, producing, communicating and transporting. Technology should not be confused with ”technical” since the former is very broad in the scope of solving practical problems, and the latter is specific and involves in-depth skills and competencies to solve these problems. Technology education is the school subject that teaches what students should know about, be able to successfully do and value in technology. There is a marked difference between the terms ”technology education” and ”educational technology”. Technology education is the evolving discipline that teaches about technology as a subject area and educational technology is the support area in education that uses technology as a means to improve the process of teaching. Educational technology more commonly deals with the use of technology through the use of hardware, devices and equipment to enhance the educational endeavor.

One of the essential means whereby we humans evolved out of our ancestral past has been because technology has been used as a powerful force to alter the human condition. Technology has both positive and negative capabilities. Unlike science, technology has social consequences to its applications and solutions. Technology can solve problems, as well as create them. Technology influences our society and culture by changing our lives and our environment. Since education is an important component of our culture, the study of technology must be an essential part of our educational core or basic subject requirements in grades K-12.Technology education can provide a wholesome continuum of educational benefits to all students from awareness to literacy to capability. It can lead to such rewarding careers as engineering, architecture and many areas of human innovation and problem solving.

The Importance of Standards for an Emerging Discipline

The National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) in the United States are funding an effort to create national standards for technology education in grades K-12. The effort is spearheaded by the

International Technology Education Association (ITEA) and is called ”Technology for All Americans.” The ultimate goal is to offer the technology education profession a clear vision for what it means to be technologically literate. The standards should present what all students should know about, value and be able to do in technology. The standards will provide criteria for assessing curriculum content in technology education (K-4, 5–8, 9–12), teaching and evaluation, which can then provide opportunities for all students to learn technology in ways that are more consistent and coordinated across all levels of the education system.

When the technology education standards refers to all students, it means that the standards apply to every student regardless of his or her background (gender, ethnicity, economic condition), circumstances or ambition. The term national means a nationwide consensus or agreement, not a federal mandate. Most certainly, the Standards for Technology Education will not define a national curriculum, nor will they suggest a form of national standardization of an actual curriculum.

The use of standards to improve the quality of technology education will have a positive impact on the student, school, community and nation. The students should be the first to benefit through enhancement of their technological literacy. Use of the standards should enhance the overall quality of the curriculum content, the instructional program, the teaching methods, the physical environment of technology education laboratories, the preparation and quality of teachers and the safety program, among other areas. Classroom and laboratory teachers will be able to assess their curriculum programs against a set of nationally developed and validated standards. After the assessment is made, curriculum and program strengths should be enhanced.

The school system should also benefit from having technology education standards. The standards should mandate that effective, open communication be established with all elements in the school system, especially those in technology, science and mathematics and then used consistently by technology education faculty and staff. Also, as a result of the standards, non-technology educators, students and parents will be informed about the technology education program, thereby generating opportunities for support, guidance and interdisciplinary educational activities.

Developing Standards for the School Subject Technology

Unlike the national standards efforts of traditional disciplines, there is not yet consensus on what the ”intellectual domain” for technology is. Technology is a new discipline and there is debate on its definition, purpose and scope. Therefore, the standards effort will begin with research and development of the rationale and content structure for technology. This is vital to the success of developing curriculum and program standards for technology education. In researching other standards, the Technology for All Americans Project has found that there are some 17 school disciplines in the United States that have developed or are currently developing national standards. There appears to be little consistency in the processes used to develop these standards. Listed below are the curriculum areas that have completed their standards or are in the process of working on them:

Completed	**In Progress**	**In Revision**
Mathematics (1989)	Economics	History
Arts (1994)	English	
Civics and Government (1994)	Global Education	
Geography (1994)	Pacesetter	
Physical Education (1994)	Technology	
Social Studies (1994)		
Business (1995)		
New Standards Project (1995)		
Foreign Languages (1996)		
Science (NRC) (1996)		

Some of these standards are content focused while others are ”process” focused. Most of the standards have some type of grade divisions such asK-4, 5–8 and 9–12 for curriculum content organization and assessment purposes. The majority of the 17 standards define their discipline in detail, as well as provide a rationale and structure (an articulated scope and sequence of what is to be taught and when it is to be taught). Most standards present some type of vision and goals for what they hope to accomplish with their standards.

The Technology for All Americans Project is divided into two phases. The goals of the two phases are as follows:

Phase I – The Project is developing a long-term vision for what should be the intellectual domain for technology education. This has involved researching and developing a rationale and structure for future technology education content. These visions will interface with science, mathematics, engineering and other disciplines.

Research has been performed on the accomplishments of standards development in other disciplines. This work builds upon processes including previous philosophical efforts, which provided a direction for technology education in the 1980s and 1990s. Phase I will culminate with publications presenting the Rationale and Structure for Technology Education.

The profession was asked to provide input to the development of the Rationale and Structure for Technology Education in Phase I and in the National Standards for Technology Education in Phase II for the purpose of obtaining consensus. Specifically, consensus workshops were conducted at seven NASA centers in the United States on the Rationale and Structure for Technology Education, during the summer of 1995. In the fall of 1995 during Phase I, the staff conducted consensus building workshops, both at regional and state technology education association meetings in the United States, and at regional and state science, mathematics and engineering association meetings in the United States. In addition, consensus-building activities were conducted through regular mail and electronic mail. Based on the input received at these consensus-building activities, a final editing of the rationale and structure will take place in 1996.

The Technology for All Americans project has a National Commission that serves in an advisory capacity to the project staff. The 24-member Commission functions independently of both the project and ITEA. A six member writing team has been formed from the National Commission. The Commission is composed of persons who are eminently aware of the need for a technologically literate society. Members represent the fields of engineering, science, mathematics, the humanities, education, government, professional associations and industry. They serve as a vital resource of experts who are knowledgeable in technology and its proper interface with science, mathematics, engineering and education. Several Commission members have been involved in the development of standards in other disciplines.

Funding was received for Phase I and a new proposal has been written to seek funding for Phase II in the near future.

Phase II – Will develop, validate and gain national consensus on standards for curriculum content in technology education for all students, with regard to background, future aspirations and prior interest in technology at the following grade levels: K-4, 5–8 and 9–12. Standards will be created for student assessment. In addition, standards for technology education programs (K-12) will be developed.

The Technology for All Americans Project also hopes to create standards for teacher preparation. Included in the standards will be all aspects of technology, as well as the relationships with other allied disciplines such as science, mathematics and engineering.

Phase II writing teams will include technology teachers, supervisors and teacher educators, as well as representatives from other disciplines such as science, mathematics and engineering. Once the first draft of the standards is produced, the consensus building process will begin. The first draft standards document will be circulated through the National Commission and to selected practitioners and leaders in technology education for feedback. The Commission will then meet to discuss the first draft of the documents. Later, the writing teams will meet again to synthesize the input given on the first draft and produce the second draft of the standards. The second draft of the curriculum and program standards will be circulated to a larger percentage of the profession and to the science, mathematics and engineering community for their reaction and recommendations. The staff will then meet with members of the writing teams to review the input on the second draft and then use this input to generate the third draft of the standards. After the third draft is produced, the staff will conduct regional consensus hearings throughout the United States.

Input will also be received from the profession at professional conferences. The staff will synthesize the input from the regional hearings, in addition to the input received at other hearings, in preparation for the writing of the final draft of the standards. As a result, hundreds of educators will have given their input into the standards in an effort to gain consensus.

Summary

Today, there are very diverse offerings in the technology education profession ranging from basic programs reflective of the early manual arts to state-of-the-art technology education programs that reflect technology based curriculum activities. It is hoped that the standards will provide a means for improving the quantity and quality of technology education programs. Technology education reform is a systemic process in which we all have roles and responsibilities to create a meaningful and productive change for the future.

Understanding the creation and development of educational standards is important in this age of accountability. National standards provide criteria by which judgments can be made at the national, regional, state, provincial or local levels on the quality of education. Most standards are based on a ”vision” of what should be and they provide concrete expressions of national goals and directions for school disciplines.

The Technology for All Americans Project has been created by the International Technology Education Association and funded by two very respected federal agencies in the United States, the National Science Foundation and the National Aeronautics and Space Administration, to develop national standards for the school subject that teaches about technology. The Project is completing its first phase which is the development of a plan for the standards that specifically addresses what each pupil should know about, be able to do and value in technology. The second phase, hopefully to be funded after the first phase, will focus on creating the standards (grades K-4, 5–8 and 9–12), as well as teacher enhancement and preparation standards, program standards and student assessment standards.

The long-range goal for Americans schools is to provide a more technologically literate and capable citizenry who will be productive and socially responsible in the future.

Primary Design and Technology in the United Kingdom

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This paper describes some in-service work with teachers in Primary Design and Technology at the University of Greenwich, London and the context in which it developed. The project was initially devised to increase the capability and confidence of local primary school teachers to deliver the National Curriculum for Design and Technology, which many still regard with concern. The same project has also been used to give Dutch teachers some understanding of this part of our curriculum and one approach to it. I hope this account will go some way towards doing the same for you. One Dutch institution, Hogeschool Katholieke Leergangen (Tilburg) has been sending teachers to the University of Greenwich for four consecutive years for a week of Primary Design and Technology that includes visits to schools. We also work with teachers from Groningen in the Netherlands. Roald Dahl’s story ‘Charlie and the Chocolate Factory’ has been the main stimulus for our work. Teachers were asked to design a new machine for Willy Wonka, the Chocolate Factory’s mysterious and magical creator. First, some of the background from which the project developed.

A national curriculum was introduced to England and Wales for the first time in 1990. Technology became compulsory in primary (and secondary) schools for the first time. Before this only a relatively small number of primary teachers had experience or training in the subject. Our locality was probably typical in that the same small bands of enthusiasts were turning up each time training was offered. This meant that their unseen colleagues were getting little, or more likely no training at all. Many teachers felt able to ignore technology until the National Curriculum made it compulsory, and then there was considerable anxiety about it. Wragg, Bennett and Carre writing in the year before the National Curriculum was introduced, give the results of two national surveys which asked teachers how confident they felt about teaching the National Curriculum subjects.

> In both surveys less than 35% of teachers felt competent to teach science, music or technology without substantial in-service support. In the case of technology only 14 per cent perceived themselves competent. (1)

Lever, writing in 1990, the year the National Curriculum was introduced, also comments on the lack of confidence among teachers and perhaps identifies one of the reasons for this:

> Teachers confidence and grounding in Science/Technology at primary level is very low. Less than 50% of them have had any in-service training in Science/Technology over the last two years. (2)

Some of those who might be expected to know about technology were also unhappy with the National Curriculum, but for different reasons. In 1992,the Engineering Council's view was that:

> Technology in the National Curriculum is a mess......
> It is not delimited so we do not know what counts as technology. Defined as problem solving alone, most activities become technology. (3)

Since then some steps have been taken in attempt to improve the above situation and many believe we now have a much slimmer, clearer and more workable curriculum. The requirements are fewer and allow teachers more discretion. Debate continues of course, but most teachers (and teacher trainers) are probably relieved that the revised National Curriculum was introduced with the intention that no more major changes would be made for five years (4). My experience of teachers on courses and feedback from students after teaching practice, suggests that a huge amount of training is still needed. I have met many reluctant and unconfident primary school coordinators for D&T. This is all the more regrettable when one realizes that these are the subject leaders in their schools and often responsible for training their colleagues. The UK based Design and Technology Association (DATA) survey in 1995, highlights this problem:

> Sixty-four per cent of schools reported that most training had been carried out internally, a matter of some concern, when the lack of specialist support in primary schools is taken into consideration
>
> ....while there is a clearly stated need for increased training in D&T, made more urgent by the introduction of the new Orders and the development of new technology, the evidence shows that the level of training is falling.(5)

The government has recognized the need to fund more training, though some would say that this should have been done earlier and that too little is being provided, for too few. This makes it all the more important that teachers are given the right sort of concentrated experience of Design and Technology when they do manage to get access to specialist tutors in higher education. The University of Greenwich is among the institutions running government funded courses in co-operation with local authorities. Such courses can be accredited towards formal university awards if participants opt for further study. Teachers need to be prepared to deliver the National Curriculum programme of study for the children they are teaching. At the start of all the programmes of study (two in primary school and two in secondary school) is the same important statement:

> Pupils should be taught to develop their design & technology capability through combining their Designing and Making skills with Knowledge and understanding in order to design and make products. (6)

The 'Charlie and the Chocolate Factory' project described in the rest of this paper began as an attempt to promote confidence through developing our teachers personal capability in a subject of which many felt they had little experience. Although the project was developed before recent Design and Technology Association research, their findings endorse emphasis on 'hands' on practical experience and personal capability.

> The key training need in primary schools is the development of practical skills in classroom teachers. Further investigation of this issue clearly shows that it is a matter of lack of confidence in many teachers coupled with insecurity of what is good practice in an area of the curriculum in which they have very little experience. (5)

The 'Charlie and the Chocolate Factory' project was specifically aimed at addressing the above, including designing among the 'practical skills'. Since opportunities for training are rare, it was important to offer a rounded package addressing resource issues, management and other concerns also. Much of this could be done in the context of the project. The Roald Dahlstory was a good context because it allowed lots confidence-building experience of designing and making with an element of fun. The story also allowed familiarity with a wide range of technology and ample scope for covering much of the National Curriculum for Design and Technology. Another reason for the choice was that 'Charlie and the Chocolate Factory' is perhaps Roald Dahl's best known work and already familiar to Dutch as well as English teachers. This meant that Dutch teachers came to London with a good understanding of the context and were familiar with at least one aspect of what they were to experience. Roald Dahl can be used to stimulate work in a number of subjects. Pritchard (7) describes work across the curriculum in his article 'A Week of Roald Dahl'. Issues of 'political correctness’, equal opportunity and fairness could also be discussed if one was so minded. Are the Oompah Loompahs treated fairly – should they setup on their own and form a workers’ co-operative!? Teachers seem to like the story because all the naughty children in it come to sticky ends! We concentrated on the Design and Technology potential of the story where the range of possible outcomes was considerable. We discussed developing and evaluating sweet recipes, making, packaging and marketing the sweets; designing chocolate moulds, dummy display chocolate bars, point of sale display stands and uniforms for factory staff. Creating new sweets for the Chocolate Factory would have been in keeping with our National Curriculum as work with food is required at primary level. These discussions were intended to show the variety possible – we didn’t have time to do it all. The outcome chosen in practice was a new machine for Willy Wonka’s Chocolate Factory. While designing and making their machines, teachers could learn about some important aspects of technology, particularly structures, mechanisms and electrics. The project allowed them to gain the practical capability to use cams, reed switches, conveyor belts and construction methods and materials. Energy sources, control (including computer control) and electrical circuits could all be included too. All this and more in a form appropriate to the primary classroom.

Before the Tilburg teachers came to London I had talked to them in the Netherlands. In an attempt to explain the intricacies of our National Curriculum (it was the old more complex version when I first went), I used videos and slides of my work with children. I also explained our curriculum by describing a project that might be done in school. Children noticing that their hamster is not as active as he used to be, put forward various ideas to improve matters. One idea is an adventure playground to stimulate and exercise the pet. My own children had designed and made such a playground and I described their work in National Curriculum terms. To bring the story to life I used a specially designed hamster soft toy. This had a 9v battery, buzzer, reed switch and capacitor circuit inside which caused the ‘hamster’ to whine when stroked with a concealed magnet. This ‘broke the ice’ as intended and the teachers gained some idea that technology might be fun after all. The ‘hamster’ and familiar and the ‘fun’ context of the story all helped to alleviate any lurking ‘technophobia’. When the teachers arrived in London they were given a further introduction to Design and Technology, which included video of children working and actual examples of practical work. Readings from the storyand excerpts from the video ‘Willy Wonka and the Chocolate Factory’ were used as stimulus. The ‘Inventing Room’ sequence showing Willy Wonka’s existing machines was particularly useful. Gradually the very polite and slightly reserved group began relax a little.

The teachers were not necessarily intended to transfer the project directly to their own classrooms but rather to recognize techniques and an approach aspects of which could be incorporated into their existing way of working. Technology is yet to become compulsory in Dutch primary schools so using the subject as means of furthering language, number and other basic skills was given some thought. Here the teachers could make a real contribution, which in turn seemed to foster confidence.

Before starting practical work teachers were given talks and demonstrations (inputs) to equip them for the task ahead. Had more time been available, tasks with key techniques as their core would have been set as preparation for the more open ended project itself. Preparatory tasks set for initial teacher training students include using a particular construction method as a basis for a simple mechanical toy or designing something for use in the classroom based on a pressure pad switch. Time did not permit this so techniques has to be learned on the more ambitious and open ended 'Wonka' project itself. Construction methods and materials were tackled first since a secure framework facilitates the success of mechanisms and other working features which follow. A range of construction kits were shown. Kits are specifically mentioned in the National Curriculum programmes of study for Key Stage 1 (5–7 year olds) and Key Stage 2 (7–11year olds)). Construction kits played a useful part in this project allowing the supporting framework of some machines to be set up quickly. Some kits e.g. 'Mini-Quadro', lent themselves to structures more than mechanisms with others the reverse was true. Providing a variety of kits helped teachers to explore their relative merits. Combining kits with parts made from raw materials and salvaged parts gave greater flexibility than using kits alone and helped avoid dependence on them. Many opted for wood sticks joined with cardboard triangles method which they were taught. The triangles were photocopied onto colored card to save time otherwise spent marking them out – the teachers did not need to develop their measuring skills. This construction method is often known in the UK as Jinks' construction after its creator. Making the frameworks in this way allowed time for design ideas to develop while they were being built. Having a framework in front of them seemed to facilitate the teachers' designing by making the problem more tangible. Creating this tangible 'canvas' still allowed considerable freedom as to what the final picture would be and the framework could always be modified if necessary. Mechanisms were also demonstrated along with ways to make them in the classroom. Conveyor belts proved particularly popular ingredients. Belts made from textiles were very successful especially when joined by elastic to create the right tension. These were often run on wooden dowel rollers covered in 'sandpaper' to prevent the belt slipping. Electrics included a variety of classroom made switches and cheap commercial ones. Our output devices were buzzers, bulbs, motors and light emitting diodes. The National Curriculum for Key Stage 2 requires that:

> Pupils should be given opportunities to work with a range of materialsand components including stiff and flexible sheet materials, materials thatare suitable for making frameworks, mouldable materials, textiles, food,electrical and mechanical components and construction kits. (5)

The inputs offered meant that this part of the UK National Curriculum could be covered easily in the course of making the project. This is true of many other aspects of the Design and Technology programmes of study though there is not space to demonstrate this in detail here. Some teachers used computer control to enhance their machine. In school this would allow the teacher to cover some of the National Curriculum for Information Technology. At Key Stage 2 (7–11 years) for example, children should be given the opportunity to create, test and store sequences of instructions to control events.

Teachers worked in groups of four. This proved to be about the right number – enough for good progress and mutual support but not so many that they got in each others way. The small groups certainly allowed aspects of the programmes of study such as 'make suggestions about how to proceed' (Key Stage 1) to be covered. Although not every teacher used every technique, the group as a whole covered a very wide range and these were seen by all. Willy Wonka style 'sweet making' machines appeared in many forms and hues. Some designs were reminiscent of Heath Robinson's fantastic contraptions. Initially reserved teachers stood on tables and knelt on the floor as they worked, often accompanying their efforts with snatches of the Oompah Loompah's song. A tremendous variety of unique and ingenious machines are produced each time one of these in-service weeks take place. One memorable design included the slightly macabre touch of having Charlie's grandparents (made in fabric) turning on a kind of rotisserie. There was a less than savory suggestion that their waste products were being recycled into chocolate! The grand finale was when each group 'performed' with their machine for the benefit of the others. Some groups wrote special songs to accompany their demonstrations, adding language and music to their Design and Technology work. It has to be said that malfunctioning machines provided far more entertainment than those which worked first time. The classroom problem of who takes group work home did not arise. Despite their enthusiasm, few of the teachers relished the prospect of trying to get their large, brightly colored and possibly fragile contraption to the Netherlands by coach, ferry and train. One group however did design their machine in modules so that it could be dismantled and packed for export. A video recordings and lots of photographs were taken home.

School visits allowed teachers to see Design and Technology in practice in the classroom. Schools were carefully selected as good practice in this subject is by no means to seen in all. The Dutch teachers also had an opportunity to sample life in an English school in general. Evening excursions to London, including a theatre pub and a show, helped group members to get to know each other and no doubt encouraged team spirit during practical sessions. To see inspiring and amusing automata teachers visited Cabaret Mechanical Theatre in London's Convent Garden. Some visited the Design Centre, the Bethnal Green Museum of Childhood and still managed to do some shopping. Welcome and farewell buffets at the University all contributed to a pleasant and positive atmosphere. The social and domestic arrangement are important as poor accommodation or an unhappy time outside the taught sessions could soon have affected attitudes within them. Happily, since the inception of this project this has never been the case. The University of Greenwich is fortunate in having excellent accommodation provided by vetted local families. As well as giving visitors experience of an English home, the hosts even collect course members from the campus late at night after they have visited shows in central London. Our easy access to the centre (twenty minutes or so by train) allows participants to combine a professional experience with a cultural one. The weeks have been judged a success and our sixth group of Dutch primary teachers will be coming to the University of Greenwich this year.

In this paper I have tried to give an account of the in-service needs of primary teachers in the area of Design and Technology which was made compulsory by the National Curriculum for England and Wales in 1990. I have also sought to give some idea of the requirements that teachers have to meet by law and modifications that have been made to them.

A considerable part of this paper has been devoted to describing a project delivered in the University of Greenwich's Design and Technology Centre in an attempt to improve local teachers confidence and capability. Of particular interest to non UK readers may be the account of how Dutch teachers have been following the same project when they came to London for a week of in-service training in Design and Technology. We welcome inquiries from others interested in bringing groups to London for similar work.

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The History of the Technology Subject in the Swedish 9-year Comprehensive School

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The History of an Optional Technology Subject

In 1962 the 6-year obligatory Swedish primary school was replaced by a comprehensive school of 9 years length. Proceeding this was a great political dispute over the question of streaming. Conservative forces wanted to differentiate from year 7 into theoretical lines of study and practical ones, thus simply reproducing the school system to be left within the school system to be erected. The most radical forces wished no streaming at all.

The solution was, of course, a political compromise and in reality pupils were divided into three streams of which only one prepared them for further studies. One of the two remaining streams was a technical one, chosen by some 45% of the boys and by less than 1% of the girls. The subject technology played an important role, taking up not less than 28% of the total teaching and learning time during the last three years in school. A look at the curriculum clearly shows that this technology subject was ”learning to labour”, the subject prepared boys for work within traditional industry.

In 1969 the curriculum was revised and the streaming was abandoned in the formal sense. In reality, however, the “technology stream” remained, only the teaching time was reduced to some 11% of the total teaching time during the 7th, 8th and 9th years of compulsory schooling. Still technology was chosen by some 45% of the boys and by almost none of the girls.

Obligatory Technology Decided in 1980 – But What Should Be the Content?

In 1980 the curriculum was once again revised. This time something radical happened: Technology was turned into an obligatory school subject and was to be taught in every grade, from grade 1 to 9. The underlying political motives were four:

- technological literacy was seen needed in a technological complex society
- equality between the sexes
- the need seen to make every school subject less theoretical and more practical and relevant for everyday life
- recruitment a driving force

The revision work was carried out by the National Board of Education and the directives for the revision were discussed in parliament and issued by the government. It was stated that parts of the optional technology subject ought to be transformed into an obligatory subject.

The National Board of Education had to find solutions to two problems:

1. Which should be the *content* of the new and obligatory technology subject?

2. Which group of *teachers* should teach obligatory technology?

The NBE set out to solve the second question first. By doing so the board, as it turned out, never would have the time to deal with the first question. The second question, as it turned out, would generate a great deal of conflict and consume most of the time available. One consequence of this was that not much obligatory technology was taught in the years to follow: Not only was a syllabus lacking, but moreover, little was done to support the implementation in general.

Back to the controversy of teacher groups. Three groups of teachers quickly "signed up" at the National Board of Education and proposed that they be given responsibility for the obligatory technology subject.

First in line were the teachers of optional technology, stating that it was simply a subject of theirs which was now made obligatory and that they were the only ones around with the capability to teach technology.

Secondly there were the teachers of craft and design, the Swedish *slöjd*. They pointed to the fact that they were in the midst of renewing their subject. *Slöjd* was formed as a subject in the 19th century when Sweden was still an agrarian society and when craft in the sense of handcraft and practical manual skills were needed in everyday life. The renewal dealt with adjusting *slöjd* to the needs of children in the late 1970s, living in urban environments and surrounded by a multitude of mass-produced artifacts. The spokesmen stressed the design-concept and pointed to the benefits of an extended subject in the line of Craft, design & technology.

Finally there were the teachers of Science. Their arguments were three: Science and technology is a unity, technology is what practical work in the physics laboratory is about for the first thing. Secondly they pointed to the fact that international research results had shown that practical technology could stimulate pupils' interest in theoretical Science. Third, it was seldom said but understood that the recruitment motive was and is a strong one in any modern society like Sweden, with several and strong aspirations to be and to stay an important industrial nation with many and well trained engineers and scientists.

The fight between the three groups of teachers clearly illustrates the multifaceted genesis of technology and the differing ideas of the content of the subject: To the teachers of technology, technology as a subject is about nuts & bolts, to the craft teachers creativity and manufacturing along with an esthetic and a cultural dimension were important aspect of that which they saw in the subject. To the Science teachers Science and technology is a unity and forms two sides of the same thing. This is a widely spread idea, and a strong one.

Outside the groups of school teachers there were some few advocates for viewing technology as part of history and of civics education. They were few, though, and at that time, the late 1970s, quite marginalised.

Thus – the subject of technology has many roots and several advocates with varying ideas about the objects of study within technology and about the ways of teaching and learning within this subject.

An Epilogue

You may still wonder about the outcome of the fight between the three teacher groups. The National Board of Education started out with the notion that Craft, design & technology was the new subject to be formed.

However, action was taken from the associations of Science teachers, and this action was addressed to the political level. The decision was – in reality – made in the Ministry of Education. The National Board of Education received some kind of signal from the political level and changed their action in accord with this. Technology was coupled with Science. Ina formal sense, the question was solved and the Science teachers were to teach the new and obligatory technology subject. The volume of technology teaching done in the 1980s was small, however.

To Learn Teaching Technology and to Become Primary School Teacher:

The Question About Technology for Age Groups 5–12 in France

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I hope to try to raise the question about technology for primary school and nursery school in France. But this question is linked with the question about primary schools teachers pre-and-in service training because there are no many activities in classrooms, with pupils. In a first time, I should show how is defined technology for primary schools and nursery schools and what it is as a primary school matter, as a subject matter. I shall try to give reasons that legitimate this compulsory education and reasons that can explain the little of practices. In a second time, I have to describe the new teachers training process in France. And in a third time, I should like to analyze the specific question about teachers training in order to teach at primary school.

I. Technology at School

To examine this double question, it is important to define what are subject matters at primary school in order to show the differences between academic subjects and subjects designed and organized for young pupils (5–12 years old)

a) An historical point of view

It is also essential to understand when and how technological education was born, how this new subject has been integrated in primary school curriculum, and to discern ruptures and continuities in the traditional ideas about education for young pupils.

In France, primary school had been organized in two periods. At first (1880), the primary school was the people's school, compulsory, secular and free. It was necessary to learn all things which everybody may not unknown. Primary school teach science and manual-work in order to know the reasons of things and the reasons of doing. Science was often applied sciences in hygiene, domestic economy and agriculture. Different for girls and boys handwork was an initiation in the work ethic. During this period, pedagogical ideas had promoted new teaching models and active methods and progressively defined scientifically education, first with observation lessons.

From the lee 1959, which had raised of the school-leaving age until 16years, progressively primary school has changed and has become school for children. In this second period modernity has impliqued new contents of general sciences and the question about technological education was born. The newborn stage of elementary school technological education has been linking with scientifically education. About 1980, it appeared physics technology in teachers training. During this same period, manual-work had become rather a esthetical activities than technical activities and in 1985was dead. Technology appears as a matter in junior high school and was included in science-technology for primary school.

b) An area for pupils

Today, "Technology" doesn't appear as an alone subject but is included in an area, which is called with different names in compulsory school. In the new curriculum (1994) this area is for age groups 3–5 "to discover the world", for age groups 5–8 "discovering the world" and for age groups 8–11 "sciences and technology". The overview of this curriculum is following:

- to discover the world
  discovering the world of things
  discovering the world of shape
  discovering the living world
  discovering the natural and human space
  awaring of hygiene, security, consumering
  the time which spend
  the world of pictures

- discovering the world
  the space and different landscapes
  the time and the life of men
  the world of shape and things
    water, air, using of thermometer in the daylife

using usual technical things
dismantling-reassembling, making, using tools
using electrical machines (4,5 or 9 V)
the world of living
the citizen life

- science and technology
  unity and diversity of the living world
  human body and health education
  sky and earth
  things and technological making
  electrical assembling
  mechanisms
  objects and produces
  computing

Junior high school is organized with three stages and currently ”technology” is defining with a new curriculum, which has two parts: technical project and process, and computing technology. Teaching is about 1,5 or 2 hours per week. For age groups 11–12, pupils have to discover and understand how to use machines in mechanics and electronics with making some things and have to understand how products go to customers with a trading point of view. In this class, they learn word-processing during about 10 hours. For age groups 12–14, teaching begin to learn technical process with four technical projects related genuine technical practices and with a technical significance as they refer essential elements of contemporary socio-technical processes in industry and services. Currently this curriculum is discussing by teachers, parents and different experts… Probably, for age groups 14–15, technology will be focus on one technical project designed by pupils. In this last class, pupils will interpret social-technical practices with conceptual tools progressively learn preceding years.

This organization square with a gradual differentiation of subject matters for pupils. However, at primary school the technological point of view has to be identified by teachers because they must be able to discern when they are teaching technology, physics or biology during activities that they propose at school.

Jean-Louis Martinand propose a model for this teaching (1995). For him ”technological education must provide both for practical familiarization with projects, processes and roles and for the intellectual work necessary for technological thinking”. At primary school, making is very important but alone is insufficient because pupils have necessary to build first intellectual tools to analyze technical world and technical things.

c) Aims for technology at primary school

It here is a political point of view. Politicians ascribe main aims to technological education from nursery schools to primary schools: (a) to discover practically world which is technical, (b) to aware designing, making, transforming methodically, (c) to have some capacities with computers, (d) to use and to communicate by different means (boards, graphs, drawings, diagrams…). These goals help children progressively in order to understand the world where they live and to act on it. However, in France the question about technological education is not at this level. It is at the implementation level, i.e. in classrooms with teachers and pupils.

d) Practices at school

Science and technology teaching appears enough difficult because there seldom practices at school. It is a basic truth to say that graduate of teachers, time, money, materials, tools… are some brakes. Indeed there is two levels of decision about curriculum: national level (ministry) where programs are defined and local level (classroom) which is the implementation level.

Studies carried out show also that teachers think science-technology as an illegitimate subject matter and don't always see interests for the child's education or his development. They consider then that this matter is a matter for junior high school and thus unnecessary at primary school. Nevertheless for about 1975, almost all activities for primary school have been designed and tested with pupils in a research at the national educational research institute (INRP) and at university (LIREST) and they always are interesting for primary schools.

New programs have been written in order to increase practices. They are simplier, clearer and more precise. New schoolbooks propose activities linked with most of points of these programmes even if they trend to separate matters in the school costumes and traditions. But it is too soon to estimate new programmes implementation, and probably new teachers have to grow up this school matter: to discover the world, discovering the world and science and technology.

II. Creating of University Teachers Training Institutes

a) a new process of teachers training and recruiting

In 1992, the university teachers training institutes (IUFM) have been creating in order to promote primary teachers similarly as secondary teachers. Nowadays they have the same grade (degree: 3 years after bachelor) and when they are teachers they are played the same. An other reason is about the university training teachers as in many states today.

Creating IUFM has changed also teachers recruiting. The new process can be draw in the diagram appendix 1. The main points are:

- the competitive examination is open for graduate candidates;
- it is open for IUFM students but also for every body;
- all laureates become civil servants and there is vocational training at IUFM during one year;
- after this year of training, they are established and become primary schools teachers.

b) much people wish to become primary teachers

Every year, there are about 10 000 posts and 40 000 candidates. Among the laureates, there are about 70% of IUFM students. Among the other 30%, 10% are students, 6% have a job in education sector and often are unestablished, 7% are without job, 4% have a job in trade or industry and 3% are ”mother of three children” for example. (1994)

c) the competitive examination

It is not a national competitive examination but a regional competitive examination. There are tests in mathematics, French, sports and two optional tests-paper. One is chosen between ”arts”, ”music” or ”custom languages” and the other one is chosen between ”physics-technology”, ”biology” or ”history-geography”. Among laureates, only 10% have chosen ”physics-technology”.

This weakness can be explained by the young teacher’s graduates, as this following board:

	Graduates	% 1994	% 1993
Human sciences	3132	33,2	*37,1*
Biology-geology	1311	13,9	*12,1*
Languages	1054	11,2	11,4
Economic sciences	933	9,9	9,4
Literary	818	8,6	10,3
Mathematics, physics, chemistry	505	5,4	3,6
Politic sciences, law	439	4,7	6,0
Engineering sciences	390	4,1	1,4
Arts	249	2,6	2,9
Sports	221	2,3	3,0
Health	221	2,3	1,6
Social carreers	221	1,7	1,2
	9432	100	100

d) the physics-technology test-paper

Each test-paper has three parts with the following objectives:

- in order to prove knowledge's in subject matter:
  - part 1: knowledge's in subject matter. The level is about at the end of junior high school
- in order to show some vocational teaching capacities:
  - part 2: analyzing pupils results, particularly drawing or written traces
  - part 3: proposing activities and pedagogical organization.

Our own study (Lebeaume & Martinand, 1996) of these test papers shows what candidates must know, i.e. which knowledge and capabilities authors whom are also teachers-trainers consider essentially.

	Questions	Number	%	%		
Academic Knowledge	Application	5	11%	45%		20%
	Concepts	8	18%			
	Contents	7	15%			
Methodological knowledge	Experimental method	17	38%	55%		
	Scientific process	2	-			
	Technological process	6	13%			
Total		45	100%	100%		

Didactical Knowledge	Pre-conceptions	6	27%			10%
	Learning process	3	14%			
	Epistemology	13	60%			
Total		22	100%			

Programs	Identifying age and level in primary school	13	10%	10%	10%	70%
Theme, topics	Listing and planning Pedagogical exploitations	17	13%	21%	20%	
	Proposing implementation	11	8%			
Lessons	Describing pedagogical process, teacher and pupils roles	35	26%	28%	70%	
	Proposing material organization	3	2%			
Pedagogical purposes	Defining objectives	21	15%	18%		
	Assesement	3	2%			
Pupils tasks	Designing document for pupils	14	11%	22%		
	Choosing document for pupils	6	4%			
	Proposing pedagogical materials	10	8%			
Total		133	100%	100%	100%	

TOTAL		200				100%

Some topics are preferred in these test-papers: electricity, mechanics and astronomy, perhaps because these subjects are easier to be in a test paper but also because there are among the most numerous activities at school.

But these test-papers already train the question about teachers training because there is some distance between areas of competitive examination and areas taught at primary school.

III. The Question About Primary Schools Teachers Training

With creating IUFM, primary schools teachers training specially for science and technology teaching has been become a topical question. Ministry has organized symposium and encouraged innovations in order to increase scientifically and technological practices at school and in order to find new ideas in teachers training.

a) the components of the question about teachers training

The previous analysis shows the essential components of the question about teachers training, as it is following:

1. primary schools teachers training concerns rather the second year at IUFM
2. thus, it is a professional training
3. at IUFM, it's only a pre-service training
4. teachers professional training needs periods of training in primary schools and periods of training in the institute
5. there are only about 20 or 40 hours to train in science and technology at institute
6. in IUFM there are teachers-trainers which are either primary schools teachers, or physics teachers, biology teachers and technology teachers or didactic professors
7. there is a long tradition of teachers training in the "écoles normales" preceding IUFM
8. primary schools teachers have to teach the whole of compulsory school matters
9. the purpose of primary schools teachers training is not only training science and technology teaching but must give primary schools teachers with their specific
10. currently, there is only a few teachers which are teaching science and technology in their classroom

11. there are many available activities in school books
12. ministry is organizing new programmes to age 3–16 years and want that pupils learn science and technology before junior high school
13. the most of students say that they are afraid or don't like sciences and don't know teaching technology

b) three trends of answers

This comprehensive view is showing that question is complex and difficult. However if we think that it's possible, we have to research the best answer to design training. Generally, two answers are given.

The first one is considering that new teachers don't have knowledge in the subject matters. Thus pre-service training is designing in order to learn knowledge (in mechanics, astronomy, electricity, physics…) and trend to forget specific aspects of professional and vocational training. To learn teaching science and technology is considered only as a question for the in service training. This point of view is not really reasonable for at least two reasons:

- to learn knowledge needs a very long time and without doubt it is impossible to learn in only a few hours the whole of knowledge in the large area of science and technology even at a basic level;
- to transfer to in-service training is enough dangerous firstly because there is no much practices in classrooms and secondly because in-service training is not compulsory but only organized for voluntary teachers. Thus, this designing emphasize the idea that science and technology teaching is allowed as an optional matter.

The second one hope to give young teachers a good idea of science and technology teaching in order to reconcile them with this area that often they avoided studying during their school time. This point of view is not very good in order to satisfy teachers training for also at least two reasons:

- on one hand it is not sure that they will teach science and technology in their classroom with their pupils. Some studies about practices have shown that there was not a direct relationship between liking science and teaching it.
- on the other hand teachers training designed as training of person needs to do science and technology at a level different as primary school. Thus young teachers have to transpose activities for children and every body know that it is the most difficult.

These two answers are not sufficient. If they are necessary, they are not sufficient because each one deal with only one training aspect: knowledge or attitudes. But not any vocational skills or capabilities can only be knowledge in subject matters. Thus designing of primary schools teachers training must be essentially analyze in professional point of view.

c) teachers training in a vocational and professional point of view

The question about professional training for primary school teachers is the question about capabilities, knowledge and skills to be able to teach this area. What is a primary school teacher? He is neither a technology teacher, nor a physics teacher, nor a biology teacher, nor an history teacher… He is a specialist of educating and teaching for children 3–11 years old. In order to raise the question, Jean-Louis Martinand says ”an ignorant person but competent to teach”. Then it is possible to examine the components of training and its organization and the question about widening and depth of this vocational training.

Jean-Louis Martinand (1994) propose an answer which is only oriented by the professional training in according to three directions: the direction from the norm i.e. reglementation and prescription; the direction from the practice in the classroom and the direction to examine ”teaching science and technology” critically i.e. with didactic tools to interpret and understand either tasks or children's difficulties. With this answer, it is easier to design curriculum for primary schools teachers training both during periods of training in primary schools and periods in the institute of training teachers. It is also easier to organized the interventions of the different experts of the training: specialist of teaching with children specialists of didactic, specialists of academic subjects and inspectors.

However, it seams necessary to examine if and how teachers-trainers are ready to change their practices of training…

IV. Conclusion

In France, currently the main question is generalizing science and technology teaching from nursery schools to junior high schools. We think that pre-service teachers training is only a professional training in order to build specifically abilities concerning science and technology teaching. Designing this curriculum of training implies to consider primary schoolteachers as specialists of educating and teaching for groups age 3–11.Thus, it is essential to raise at least three questions:

- the question about the school matters;

- the question of the place of science and technology and its relationships with the other matters in the curriculum;
- the question of the partition of the training which can not only be neither the one of academic subjects matters, nor the one of the teachers-trainers, nor the one of training in classrooms and training in institute, nor the one of pre-and-in service training.

I have been trying to give some elements to define widening and delph ofthis training. And I think that the question about technology teachers forjunior high school is enough similar.

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Technology Education and Sustainable Livelihoods

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The Context of Education

To go on or not go to school has today become less contentious amongst ethnic communities in Kenya and I believe in most African countries. Towards the independence period, literacy or illiteracy were important campaign points used by those who were coming to power. It took a while with lots of doubts for many parents to accept schooling as an important means of acquiring knowledge. Not that indigenous communities did not have their valid and often very relevant systems of education. They truly did but the point was, if they wanted to rid themselves of scourge of life as disease, ignorance and poverty, they had to adopt a new system of education and send their children to school. The system used by the communities over the year were in most cases declared primitive and worthless.

After 30–40 years of independence with all kinds of adaptations/adoptation these very system of education are being debated and doubted. There have been review and more reviews are till being called for. In Kenya, systems of Education have switched round, and even the 8–4–4 system of Education which was launched in 1985 as a problem-solving, practically oriented education system suited to self employment is almost being thrown out. Not with standing the positive moments of growth, it is a fact that there are more serious problems that have been exacerbated by the philosophies and system of education. The world and its resources are currently critically threatened. It is uncertain how much longer life will remain on earth if certain habits and initiatives are not checked. This is why in our communities there is concern about the trend of things. They are continuously getting worse, right from the natural resource base, the economy; health even control of people's destiny. In many ways life is threatened on earth.

On the education front, already the value of school subjects must be questioned. To what extent are these subjects contributing to the mess in the world or might they be the sevior. What should be the main considerations for growth of a subject and it's introductions into the school curriculum. Which subjects should have more time in the time table and why? What would be the order of priority in which subjects should be taught in the school timetable? How should community need and genuine challenges in life be matched with school subjects? Which subjects are more prone to tackling problems in society and to what are they taught in the schools? These are genuine concerns that are being mentioned in most for a. As it were going to school today does not ensure or guarantee a job and in many ways it does not prepare people well enough for any form of occupation. To many parents/communities there is a great mismatch between expectations of education and the surrounding realities, which are manifested in form of poverty, health problems and destruction of the natural resource base. The wonder is, should these communities revert back and rehabilitate the indigenous system of education to help rid themselves of these problems? This is a question that is pending in the minds of many. In fact as many allude, the world would today be a better place if different cultures were allowed to develop and form basis of world development. The unique talents in different societies would have had a chance to evolve and take care of needs of lives in their space. This is to say that perhaps one of the oldest subject disciplines as part of day to day activities has been technology education. Wherever it is whichever encounters, human life has a lot to do with solving problems in order to survive. Technology education must therefore be an important core subject in the school curriculum; and in fact it is its absence in most systems of education that has resulted in the many problems experienced.

The Responsibility of Technology Education

Arising from concerns of different communities (of the world) about ensuring quality of life at all times, and the state of the natural environment which is speedily being destroyed, there is a genuine concern on developments of Technology. How should Technology Education impact on technological developments in society to ensure sustainable livelihoods. Is there a role for technology education to ensure sustainable livelihoods? As we all know, in most cases the developments of technology are intended to improve/extend the capacity of human want which did not fully translate into sustaining life. It only helps up to a point, and then it become counter productive. There has also been a lot of exploitation and destruction of nature that has accompanied and resulted from technological encounters. So that if the subject Technology aims at refining technological capacity, the nature of problems tackled or proposed and to whose benefit has to be addressed. The process of technological activity must be related to all the realities that surround the identification and utilization of resources. And the purpose for which a solution is sought must be a matter of debate, before sanctioning of the activity. Technological capability must not be left to be a creative process where talent is employed to tackle any problem in sight without assessing the possible impact on life and nature.

Take an example of wanting to make paper to facilitate writing: Most paper is made from certain trees. If the exercise to come up with paper from a tree is achieved, then that must not be the end. This is because after opening the discovery of paper people will be excited by its availability and the possible trade and income implications. But there is the questions of the source of the raw materials (tree) and where it will be grown. And it is just this because there is an issue also of biodiversity destruction to make space for the “paper tree”. On the other side, there is the issue of the destructive nature of what comes out as waste in the process of making paper. Similar case could be mentioned of all products arising from the technology e.g., metal mining up to effluent arising from the process of producing products, petroleum based products, biological products, etc. Problems of the technological products even go as far as the impacts of their use e.g. planes, fertilizers, Z-rays, land mines, pesticides, etc.

It is clear that technology education has a wider scope than currently envisaged and a much broader responsibility in ensuring sustainable livelihoods. It is those creative individuals of all shades who will make or break the world with their creation if left loose without guiding principles.

Technology education must be focused on sustainable livelihoods. Because Livelihoods arise from the fact that nature is interdependent and you need other lives to survive. Hence all life are important and must be preserved. As a matter of fact sustaining livelihoods call for unique skills, knowledge, aptitudes, attitudes and experiences that are specific to given situations and space. A technology education curriculum should recognize this and build on it and not assume it. This is to say that forest communities knows more about the forest species, what each species is about an could be good for that other person and so is lake or coastal communities. With culture-specific technology education, they could make the most efficient and relevant technologies suited to fulfillment of livelihood needs. They would have specific ethics to guide their relationship with resources and care for the materials and sources for technological activities. The danger today is the universalization of techniques and technological practices which are translocated from other cultures. Together with technological supremace and domination it is clear that Technology Education in many curricula especially in Developing countries does not create the necessary impact in sustaining livelihoods which should be the principle objective. Technology education is not a subject like all other where relevance is not a critical question.

Principles of Technology Education

Although many school subjects have been left without specific guiding principles to help define boundaries and impact, it would be dangerous if technology education would be left that loose. Particularly when the subject is targeted to help build a capability to sustain life. It is felt that being new in the school curriculum, a lot more needs to be done. The following are some important principles;

1. Resources of the World are finite, hence their use or conversion into any form must be carefully restrained.

Currently control of the rate of exploitation of resources is weak and marred by that varying needs of different people. There has to be a way which ensures reduced exploitation to allow for continuous availability. The principle must be interpreted into all creative technological processes in the curriculum where the use of materials is paramount.

2. All life on earth is supreme and must be protected; hence any action which may injure or destroy it must be curtailed.

Technology Education, because it is founded on the use of materials which could be life or supports of life must be sensitized to finding a compromise, in the search for solutions to problems. If you have to cut a tree or destroy a vegetation which could be a habitat or support biodiversity a lot of care is required. These should be concerns for technology curricula since excessive use of certain materials disturbs natures equilibrium, and the products of technology like wise could be destructive.

3. Talent and creativity is a human gift and not the preserve of only a few people, hence each person must have the opportunity to unlease this gift while observing the limits of destructiveness.

It is true that human mind can come up with anything useful and equally destructive Technology Education must understand this and limit freedom in that direction.

4. Culture forms the base form which unique skills, knowledge and experience evolve, hence all technological practices must reflect its strength and origin. Technology education should maintain a search of cultural strengthen by being sensitive to cultural identity, dignity and integrity in any technological

innovations. Cultural base of different communities must be upheld at all times in trying to fund solutions for life problems

5. The World is a one-vast-interconnected world with unique characteristics offering all opportunities required, hence responsibility for action is for all, and not “us and them“.

Whatever happens in one part of the world at some point in time has some impact in another part and back again. All technology education activities must pay attention to the responsibilities of solutions generated and their impact in all parts of the world.

Although these principles are broad and needs refinement, it is a fact that the world today require responsible action and a visionary approach.

Conclusion

Science and Technology have been recognized and given a lee way in contributing to national development, and it is true that from time immemorial they have been part of many world cultures. It is the belief in this paper that they have lacked a focus and only concentrated on humans one direction of solving problems at the experience of all other live. Given the kind of impact so far obtained from them, there is need to refocus again on them but with a critical concern on life and livelihood sustainability. This should be the main guide for Technology Education.

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Teacher Training in Technological Education in Finland

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As in many countries, technology education in Finland is still in the early stages of a long term development process. Changing the subjects in the school curriculum needs a lot of time (APP 1).

The name now used for technologically oriented subjects now in Finland is ’Technical Work’. At the moment it is a part of ’Crafts education’. The appropriate strategy might be to talk about ’technological education’ in order to activate more than just the craft teachers.

Turku University, Rauma Teacher Training Department, has had a monopoly in Technical Work subject teacher training. It has been done there for about 35 years. The tradition of training is craft-based but the influence of new technology has been realized for years. Also the old emphasis on electricity and machines has naturally brought in electronics and control technology.

Helsinki University has Textile Work teacher training. Added to that, **Joensuu University, Savonlinna Teacher Training Department,** has the Home Economics training covering also Textile Work. Training in Helsinki had already begun about 130 years ago.

Oulu University is a newcomer in this field. In 1992 Oulu University was permitted by the Ministry of Education to start 'exceptional subject teacher training in Technical Work' because of the regional lack of teachers in Northern Finland. Actually initiatives were proposed many times to Rauma TTD but without result. In 1991 The National Board of General Education presented a new initiative to the Ministry of Education, and Oulu was permitted to organize training. At the same time, however, Rauma increased its intake from the normal 24 to 35.
A new type of Technology Teacher Education will begin in Oulu in 1996. 20

primary level class teachers will have the opportunity to study Technology Education for 35 credits (study weeks) as a second subject. This will enable him/her to teach TE at the higher comprehensive and senior secondary school levels, although not as a full-time subject teacher (APP. 2). Oulu has good facilities and infrastructure for new training; the University has Faculties of both Education and Technology under the same roof which makes it the only University in Finland with such an arrangement.

All primary level class teachers in Finland traditionally get brief training either in Technical Work or Textile Work. Teaching vacancies in the schools are normally arranged with an obligation to teach in one of these two subject areas.

Recent Developments

In 1971-1991 there was a steady development trend from Crafts to Technology Education. During that time The National Board of General Education wrote the curricula for the schools and was responsible for In-Service teacher training.

In 1979 a paper for a new subject, 'Technology and Education for Work', was written under a committee for reforming senior secondary education. It was, however, not realized as such, but technology was included in Science education. That brought about a significant development in Science Education; industrial visits, pedagogical versatility, etc.

In 1991, as the last working group before the dismantling of the office, the National Board drew up a plan for introducing Technology Education. It was a late innovation when compared to world mainstream development. However, a substantial number of the relevant innovations in content in technological education had already been made during the preceeding 20 years; e.g. launching electronics and computers in the school. The group also proposed 'Technology' as a new school subject.

In 1992 a working group at the Ministry of Education wrote 'Guidelines for the Weekly Periods' as a curriculum blue paper. The trend was changed. The report emphasized the old Craft content again. "Technology" as a new term was discussed in the paper but criticized as being too theoretical, so that it would not be practical enough to replace Crafts. Also there were some interest groups in the country, which wanted to retain Crafts. Another proposal was 'Design and Crafts', which, however, was not approved, e.g. by the teachers' pedagogical organizations.

In 1994 the new National Board of Education published the curricula for the comprehensive and senior secondary schools. Technology was highly valued as a basis for education at both school levels and in the different subject contexts, but it was not approved as a new name for the subject. However, the newly introduced model represented a new type of curricular thinking, giving quite a lot of freedom to municipalities and schools to write their own curricula and to develop new integrated subjects and options. For this reason it is much more possible today to offer Technology as a school subject. Some primary, junior secondary and senior secondary schools have actually implemented this.

So, in Finland both international innovative trends in ’New Crafts’, Technology and Design, have been tried. They have been adopted, even if the name of the subject has been kept as it was 130 years ago. We can say, that the technological development of the country is hidden in the curriculum in Finland.

Science and Maths

In Science Education the main interest in the 1980's was in pedagogical development. Science teachers have traditionally been academically trained scientists and mathematicians with not much experience in pedagogics. When the teacher training system was reformed, there was the need for In-Service training of the already existing teachers.

Science personnel at the Helsinki University Teacher Training Department worked in close collaboration with the appropriate school authorities. Also the UNESCO INISTE exercised a strong influence in modernizing the subject. Iniste also had an idea for introducing technology education. Since the initiators of the new activity were scientists, the influence did not reach the real technology educators. Nevertheless, technology was introduced to make basic Science education more versatile, practical and motivating.

At Joensuu University in 1989 Jorma Enkenberg wrote his doctorate on children’s’ scientific thinking. He has recently, with his colleague Mr. Lakotieva introduced Lego/Logo for technological education. The original idea for that was introduced at an In-Service teacher training course in1986 organized by the National Board. Then the Lego Automatic series was introduced for the first time in the country, in a course in which Mr. Lakotieva participated. Enkenberg has also researched the “Apprentice Method” in Science and Technology Education. Undoubtedly it has one of its origins in traditional Work Education.

At Helsinki University a productive Science Education research group has been founded around Professor Meisalo, in the Faculty of Education. Jauhiainen, Lavonen and Kuitunen have achieved doctorates within six months; Jauhiainen in general In-Service teacher training strategies; Lavonen in designing EMPIRICA, a computer-based measuring unit for Science Education; Kuitunen in innovation strategy in FINISTE. Sahlberg will attain his doctorate at Jyväskylä University in May 1996 in In-Service training strategies.

Professor Kurki-Suonio of the Physics Department at Helsinki University has recently begun to write about two interrelated areas in Science Education; (1) Didactics (pedagogy) of Physics; and (2) Didactical (pedagogical) Physics. In the case of the latter some kinds of technological applications may be involved.

Mathematics has not been very progressive in the last 10 years. In the 1970's the New Math's Movement naturally was adopted also in Finland. As elsewhere it was gradually and silently removed. However, nothing has been brought in to replace it. The textbooks have been practically the same during the period 1970-96. There has been some private pedagogical development activity. (Haapasalo in Jyväskylä).

In-Service Teacher Training

At the moment there is no longer any centralized In-Service teacher training system in the country. The National Board has organized "Aquarium Schools" for launching different kinds of innovations. The annual conferences and exhibitions disseminate the good practices. In-Service training is taken care of by the regional In-Service training centers and paid for by the municipalities.

Generally, discussion on e.g. a **constructivist approach** is going on at the moment in the country. Its concern is with the whole school, but with special attention being given to the mathematical-scientific subjects.

The Future of Technology Education in Finland – A promising Future

- The new training scheme in Oulu has awakened interest in the other TTD's.
- There is a new interest in research in the area
- There is quite a high commercial interest in the country to bring Lego/Logo to schools, even though it was already tried ten years ago. Some Science educators especially tend to think that Technology Education only means the use of Lego/Logo or increasing the amount of equipment. A CD-Rom is also in the pipeline for inclusion in Lego/Logo to be delivered to all Primary Schools (most of which do not have the facilities...). Nevertheless, Oulu University also has a research project being carried out at the moment on Lego/Logo (Esa-Matti Järvinen).
- Founding a national Technology Education Society was planned in Jyväskylä in October 1995 and will be founded in June 1996.

- New teaching materials have just been published, e.g.: – a kit and a textbook for electronics education supported by NOKIA, ICL and ABB; – a series of constructional kits, the first one being ’Hydrocopter’; – ’EMPIRICA’, a computer-based measuring unit for Science education.
- Some international and national meetings and conferences have been organized, e.g. Heinola in 1989 and 1991, Jyväskylä in 1995 and 1996, Oulu in 1996, and Finns have been introducing innovations abroad, e.g. in PATT in the Netherlands in 1986–1995, in UNESCO and in OECD in different contexts, in WOCATE in Weimar 1992 and Paris 1993, in Israel 1996.

As a new approach there is some interest at the moment in introducing teachers' collaboration. It will also mean the integration of subjects. Attached you will find a form to be filled by the teachers in order to discover possible areas of integration so as to motivate them towards cooperation (APP. 3).

Design and Technology in the Australian Curriculum

Associate Dean Marianne Hulsbosch
University of Sydney

The 1989 national collaboration among the States and Territories in Australia resulted in common and agreed goals for schooling. The study areas were divided into eight Key Learning areas, they are:

- English
- Mathematics
- Science
- Technology
- Languages other than English
- Health and Physical Education
- Human Society and its Environment
- The Arts

Statements and Profiles were developed for each Key Learning area and provide a framework for curriculum development by education system sand schools.

- The Statements provide a framework for curriculum development in each area of learning. They define the area, outline its essential elements, show what is distinctive about it and describe a sequence for developing knowledge, skills and attitudes.
- The Profiles describe the progression of learning, typically achieved by students during their compulsory years of schooling (Years 1 –10) in each area. The profiles are designed to assist in the improvement of teaching and learning and to provide a common language for reporting student achievement.

Through the Technology learning area, students experience a variety of technologies that:

- are relevant to contemporary issues and needs
- have social and economic significance
- improve the quality of life at home and in the workplace
- are ecologically desirable and sustainable
- are particularly relevant to Australia
- relate to student interest and needs

Through Technology programs students learn to reflect on past practices and future opportunities. They develop an understanding of the influence different groups can have on how technologies are developed and used. They learn to think critically about how technology affects them, their local community and the world. They are able to devise criteria for evaluating the impacts of technology on societies and environments.

Tasks and activities in Design and Technology education assist students to identify questions to explore, to synthesize ways of putting ideas into practice and to implement plans. For example students are encouraged to:

- build on their experiences, interests and aspirations in technology
- find and use a variety of technological information and ideas
- show how ideas and practices in design and technology are conceived
- explain design and technical language and conventions
- take responsibility for designs, decisions, actions and assessments
- trial their proposals and plans
- take risks when exploring new ideas and practices
- be open-minded and show respect for individual differences when responding to technological challenges

Design and Technology programs in the schools involve students in generating ideas and taking action as well as in using and developing processes and products that satisfy human needs. In doing so students develop their knowledge and understanding of technology in the past and present, and examine future possibilities and emerging trends.

Design and Technology programs integrate theory and practice. They include much that is scientific, ethical, mathematical, graphical, cultural, aesthetic and historical. They encourage students to explore the synthesis of ideas and practices, and the effects of technology on societies and environments.

The four strands of learning are:

- designing, making, appraising
- information
- materials
- systems

All learning in Design and Technology involves the designing, making and appraising, with equal weighting given to all. The relative emphasis on information, materials and systems varies according to the needs of the students and the nature of the program and activities in which they are engaged.

In the secondary school, Design and Technology brings together a number of different areas of study. For example they include:

- Agriculture and Rural Studies, which gives the students experience of technological systems related to land management, food and fib reproduction, plant propagation, animal keeping and care.......
- Computing/information technology, which presents the students with opportunities to apply information, create networks, manage systems for data input and retrieval, transform data, and to devise programs and solve problems........
- Food Technology and Textiles Technology, which gives the students experience of production and processing associated with foods and textiles, management and maintenance of services and industries. Issues relating to society and aspects of personal health and hygiene......
- Media Studies, which provides the students with the opportunities to understand interrelationships between technologies used in mass media communications and multi-media networks, and to manipulate media for presenting information, and to explore the impact of media on individuals and society........
- Applied Design which encourages the students to design and construct using natural and synthetic materials, to explore the generation and conservation of energy, and to produce electronic and mechanical systems......
- Industrial Technologies in which students develop comprehensive skills in analysis, investigation and application of engineering concepts and principles in specific contexts......
- Graphics, which provides students with opportunities to develop communication skills of ideas and concepts using graphic means, thus enabling them to visualize solutions to design problems.........

Design and Technology also involves the development and application of ideas and principles from other areas of learning. They include: the applied sciences, engineering of many kinds, business and commerce. The nature, content and processes for the technology learning area provide coherence for the development of technology programs that incorporate these areas.

Design and Technology Education in N.S.W. Schools

The Course

In the secondary schools, the 2 part course (Design and Technology syllabus years 7–10 and the Design and Technology syllabus years 11–12) is built on the educational experiences in the Science and Technology years K-6 course. Both syllabi are built on the design process and its dimensions.

The Design and Technology syllabus years 7–10 is a mandatory 200hour course. This syllabus focuses on the study of technology and its application through design in personal, community, industrial and commercial settings in rural and urban environments.

The Design and Technology 11–12 syllabus builds on the student's educational experiences in Design and Technology 7–10 syllabus and provides the student with the opportunity to pursue areas of inquiry in greater depth and acknowledges that the students become more autonomous in their learning. It is an elective course with an indicative time of 300 hours for a 2 unit course and an additional 150 hours for a 3 unit course. The unusual feature of this course is that the students are to complete a major piece of work (THE MAJOR DESIGN PROJECT) including a design portfolio based on technological contexts.

The Design Projects undertaken throughout the course allows the students to experience and be involved in hands-on activities of design and technology. The students are encouraged to identify the relationship between the activities they undertake in their Design Projects and those design and technological activities that are taken in the wider community. This linking will assist the students to develop abilities to operate and apply their knowledge in other settings. In addition, the students will develop specific knowledge, skills and attitudes by understanding research and development related to an aspect of their Major Design Project.

In the additional 3 Unit course the students will investigate the nature of innovation, success of innovation and the entrepreneurial activity that take place in the wider community. This course caters for those students who are particularly creative, innovative or enterprising and who wish to extend the depth and scope of their study. This 3 Unit course will involve students in undertaking a

SPECIALISED STUDY, which will critically analyze one aspect of the 2 Unit Major Design Project. The Specialist Study will result in the investigation of an innovative application, a new improved resource, a manufacturing system or a marketing strategy.

The Related Study and Design Projects

The Related Study and Design Projects specify the content of the 2/3 Unit course. The Related Study provides the opportunity for the students to gain knowledge, skills and attitudes about design and activity. The topics in the Related Study include:

- designing and producing
- using resources
- management, communication and marketing
- relating issues to design and technology

Students are encouraged through the Related Study to practice relating knowledge and skills to, and applying their knowledge and skills from, one context to another. The Design Projects are the main activity undertaken during the Related Study. They provide the students with the opportunity to learn within contexts that they may find meaningful. The activities undertaken, may relate to the various roles students may wish to adopt on completion of their school education.

The Comparative Case Study

A significant component of the Related Study is the Comparative Case Study. This involves the investigation and comparison of two organizations of different size and structure. Through the Comparative Case Study students will develop a broader appreciation of design and technological activity. The knowledge, skills and attitudes gained will reflect the diversity of design and technology in the wider community.

The Case Study consists of a comparison of the operation of two organizations. This comparative approach increases the student's awareness of the diversity of operations and allows the students to identify the reasons underlying the nature of different operations.

The two organizations should differ in size and structure, but may deal with similar or different products, systems or environments. The organizations may operate in domestic, community, industrial or commercial settings in rural or urban environments.

The Major Design Project

A major element of the Design and Technology syllabus in NSW schools is the undertaking of a number of Design Projects, chosen from a range of Prescribed Contexts. These contexts address stated Prescribed Dimensions.

These Prescribed Contexts within which design projects must be selected include:

- Agriculture
- The built environment
- Clothing and accessories
- Engineered systems
- Food
- Health and welfare
- Information and communication
- Leisure and lifestyle
- Manufacturing
- Transport and distribution

Each design project must address all of the prescribed dimensions of:

- Resources people, materials, tools, energy, time, skills, finances, information
- Domains personal, commercial/industrial, global
- Human impact cultural issues, environmental sustain ability, ethics, gender issues, historical issues, motivation, quality

In each project it is imperative that the following skills are considered: designing, making, evaluating, communicating, marketing and management.

The Major Design Project is a practical hands-on activity, in which the student develops and realizes a product, system or environment. The Project will be influenced by the student’s skills, ability, interests and the availability of resources. The Project may, or may not be related to the organizations investigated in the Comparative Case Study. It is submitted for Higher School Certificate (HSC) Examination marking and should be accompanied by a Portfolio.

The Portfolio

All activities involved in the design and production of the product, system or environment should be documented in a portfolio. This portfolio is to be submitted with the major design work for HSC Examination marking.

The portfolio should indicate clearly an understanding of the process the student has followed in the development and realization of the project, from the first ideas through to the evaluation of design, product and process. It should state exactly what the student was hoping to achieve and all the plans they put into place to implement their goals. It should show alternatives the student considered at each step of the process, and the evaluation undertaken in order to make sound decisions.

Design and Technology in the Classroom

Several models for the structuring and implementation of the Design and Technology course are offered. It is the schools decision to select a suitable model for the total course or they may vary their approach from unit to unit.

Three such models are described below:

<u>Open choice model.</u>
The open choice model involves the group being structured in such a way that the student can select Design projects from a free range of choices. The students are able to follow any area of interest.

<u>Facilities based model.</u>
The facilities based model involves the group being structured so that the student's choice of Design Projects is limited by the facilities (including rooms, equipment and materials) made available to the students, e.g. agriculture, computing, textiles, woodwork etc.

<u>Thematic model.</u>
The thematic model involves the group being structured so that the student's choice of Design Projects is focused on an area of application, e.g. sport, theatre, furniture, fashion and accessories, animal husbandry, land care, tourism etc.

<u>A cross curricula model</u>
The key principles and concept of Design and Technology education provide the ultimate framework for schools to integrate across and between key learning areas,

and thereby focusing on the whole student, rather than individual subject areas. Different approaches to cross curricular activities are considered.

Vocational Education Integrated in General Education

Training and Further Education (TAFE) Colleges are vocational education colleges. In the past, students could leave after Year 10 and continue to do a TAFE course which would give the student vocational skills and qualifications. By having to choose one path or the other, Year 10 students were to make a fundamental decision by an inflexible system. This situation created two streams of Year 10 graduates: those who chose to stay at school to complete the Higher School Certificate in the hope of going on to University; and those students who would continue on to a TAFE course.

Therefore the need to co-ordinate policy to broaden the options open to Year 10 graduates was clear and the result is that alternative pathways have been created. The policy has established four broad pathways which each offer students access to a range of intersecting studies in a more flexible framework. This allows for students to seek a more active role in our society.

PATHWAY 1
Provides for an HSC delivered by schools and focused entirely on a general education, without specific study towards recognized vocational education and training, continuing a traditional pathway into university.

PATHWAY 2
An HSC delivered by schools which include both general education and recognized vocational and training components.

PATHWAY 3
An HSC delivered by the TAFE Commission, which includes recognized vocational education and training components.

PATHWAY 4
Vocational education and training delivered by the TAFE system, industry or private training providers, which – although not leading to an HSC – provides students with a direct pathway into post-school vocational education and training.

These pathways are specifically intended to help young people between the ages of 15 and 19 reach their full potential by giving them access to a broader, more interesting and equitable range of study options throughfull- or part-time studies towards their HSC in a school or TAFE environment. So, in effect this means that during their HSC years, candidates can undertake vocational and training courses in High School or TAFE College settings. This is of special benefit to school students who stay at High School to complete their HSC and then wish to transfer to the TAFE system. Vocational and industry-based courses included in the HSC will be accredited and acceptance of these courses make the majority of study credits readily transferable. This means that students who successfully complete a TAFE accredited course at school level, will be granted a first year accreditation in their actual TAFE course.

The inclusion of TAFE accredited courses within High Schools has not only had a major impact on Secondary Design and Technology Education but also on Design and Technology Teacher Education. Several TAFE accredited courses can be team-taught with Design and Technology teachers and TAFE staff. In the joint School/TAFE program the school student ultimately benefits greatly from the coordinated courses offered by the School.

Thus, close links have been developed between local TAFE Colleges and the TAS Department at the University of Sydney, to allow our students during their 4 year course the benefit of working in specially appointed laboratories and workshops in the TAFE Colleges. (For instance in industrial and commercial food preparation areas). Our students, with their education background in design methodology and pedagogy are a very welcome contribution to the TAFE courses.

Design and Technology and the Wider Community

The effective implementation of this course depends on the information of parents, the community, commerce and industry of the philosophy, rationale and content of the Design and Technology Syllabus.

Parental involvement.

Parents are encouraged to provide opportunities for their children to experience a wide range of design and technological activities. They should encourage children to accept challenges and they should draw upon their own expertise in all aspects of design and technology. Parental involvement can include direct involvement such as informative presentations of parent’s business or personal skills, demonstrations and student’s site visits.

Parents are actively encouraged to participate and share their expertise with their local school community.

Community involvement.
Schools should incorporate a community focus when planning of design and technology learning experiences. Schools are to encourage and incorporate active community involvement in a similar way that they involve parental participation.

Industry and Commerce involvement.
The students are encouraged to be involved in the study of industry/commercial activities. The schools can use the programs specifically designed to assist in teaching the industrial/commercial aspects of technology, e.g. schools' "Visit to Industry Program" (VIP) and the" Education Business Partnerships" program.

Through the industry/commerce involvement programs the student will be able to identify organizations for investigation in the Comparative Case Study.

Technology education enables all students to develop skills, understandings and attitudes which cross many disciplines. They understand achievements of different cultures and societies. In coming to appreciate their roles and responsibilities in making ethical and informed decisions about technology, students gain a sense of understanding and control over the applications of technology

Bachelor of Education (Technological and Applied Studies)
Master of Teaching (Technological and Applied Studies)
Teacher Education at the University of Sydney

There are almost 40 universities operating in Australia and they are attracting a great amount of interest from Australian and overseas students. The high-quality courses they offer have proven to be very successful. The University of Sydney is the oldest university in Australia and has a proven track record. At the Faculty of Education we have carefully considered the recent changes in education and especially within Design and Technology Education. We have created a new course in1992, to prepare our students to take Design and Technology Education into the 21th Century. We at Sydney University are the only faculty who offer an undergraduate course in this format and we believe that we offer the best course with the best possible options.

The Bachelor of Education (Technological and Applied Studies) is a 4 year full-time degree course which prepares graduates to teach a variety of subjects in the Technological and Applied Studies Key Learning Area, in NSW Australia. All graduates will be qualified to teach Design and Technology Years 7 – 12, (2 and 3

Unit) as well as two or more of the following: Food Technology, Engineering Studies, Techniques, Textile Technology, Graphics, Industry Studies, Applied Studies, Computing Studies.

The program at the University of Sydney consists of five integrated components: Education, Design & Technology Core Studies, ProfessionalStudies, Practicum and Curriculum Studies. Students undertake Educationin Years 1, 2 and 3; Professional Studies (ie. Secondary Education) andPracticum (60 days in total) are undertaken in Years 2, 3 and 4.

Six Curriculum Studies are studied in first year, they are:

- Applied Design
- Applied Graphics
- Computing Studies
- Food Technology
- Industrial Technology
- Textile Technology

Three Curriculum Studies are selected in the second year. In third year two of the three Curriculum Studies chosen in second year must be studied. In fourth year, students continue with the same Curriculum Studies they elected to study in third year.

To allow for in-school experience, a structure has been developed interfacing Education Theory and Teaching Practice through the Practice teaching model. Through this arrangement, students are placed in a High School where they can teach in carefully constructed environments and under supervision. During the 4 year course students will have a minimum of 60 Practice Teaching days.

An Education Honours program is available to those students who pass with sufficient credits to warrant admission.

Students can continue and apply for entry in the Master of Education, Doctorate and PhD courses currently on offer.

<u>The Master of Education, (Technological and Applied Studies)</u> course is a 2 year full time pre-service professional program which is a rigorous and issue centred course, built on successful completion of Technological and Applied Studies courses. The program involves close partnerships with selected co-operating schools and their staff, including an extended Internship for a full term during the final semester.

The objectives of this course will encourage and allow students to generate for themselves issues they need to consider as intending teachers; it will fortes independent and small group learning, will encourage throughout critical reflection on what students are learning and experiencing and will require the development of a portfolio, incorporating a record of their experiences, self evaluations and reflective tasks.

The delivery mode of the courses feature problem-based and case study approaches. This allows Faculty staff members to reflect in their work the latest thinking with respect to effective pedagogical practices and state of the art technology. Their approach will be based on a team approach in order to foster integration and cross-linking amongst program components.

Numerous Professional Development courses in Design and Technology and related courses are also offered by the TAS Department throughout the year.

The Faculty's teaching model prides itself on the educational depth and breadth in the subjects it offers. Considering the diversity of our courses within the TAS Degree, they share a common goal: Education. We prepare our students for a flexible future and generic teaching skills, form the basis of our Bachelor of Education degree. Our aims are to stimulate reflective inquiry to enable our students to become reflective practitioners; to stimulate generative and critical thinking to enhance their teaching skills as well as their design and production skills.

The facilities at the Faculty are first class, in 1994 we have taken possession of a brand new building with all the latest facilities included. This opportunity allowed us in the Department to reconsider the facilities we had and to update and upgrade our equipment. Especially the Information Technology Laboratories are the very best in the country.

Video conferencing is another media which is used at the TAS Department and brings together industries, country students, students and lecturers at other universities in Australia and ourselves. Telecom Australia uses this technique extensively.

Design and Technology Education forms the core component of the TAS degree. Especially the Curriculum Studies contain a healthy component of student centered learning. This approach of self learning enhances not only generic teaching skills but also life skills, design skill sand production skills, all essential to the development of a successful Design and Technology teacher.

The course at the Faculty is not static, but allows for a great deal of individual interpretation. The principles are set and a holistic framework is in operation however, students can select the Curriculum courses to suit their individual needs and goals. Therefore we feel we have created a highly personalized degree-course which delivers a motivated, highly qualified teacher who can contribute positively and successfully to the development of students in a variety of learning experiences and design contexts.

Through the Schools' Visit to Industry Trainee Teachers Program, activities are developed to assist in the professional development of student teachers and professional development for teachers already out in the schools, e.g.:

- workshops with business representatives and educators on: "Industry Expectations in Schools"
- lectures on "Department of School Education Business Partnership Programs".
- visits to company sites.
- on-site training in the development of industry materials for schools etc.

Through the use of such programs as Schools' Visit to Industry Trainee Teachers Program and initiatives from individual lecturers, the TAS Department at the Faculty of Education has developed strong links with business and industry. The Department has benefited in many ways and ultimately the student teachers are experiencing a positive introduction to business and work environments. This will enable our students to prepare their pupils for a more realistic and more holistic view of their future working life.

To prepare our students for this enormous task, several courses have been designed to develop those skills, needed to teach in such diverse and challenging environment.

During their 4th year all students participate in a Major Design Project. This course is essentially a self directed course with an initial set of lectures. Small groups of students are appointed to tutors who then guide them through their project development.

The course has a strong focus on reality based learning. The aim is to broaden the student's often limited perception of problem solving in industry, business, community and organizations. The students are required to combine design, research and technical skills to implement an independent design project. Throughout, they have to demonstrate an understanding of a range of design/problem solving and technological activities and their applications in a variety of settings.

They have to develop knowledge and skills in the management and use of resources and processes; the use of communications technology; the development of creative solutions to design problems as well as show skills in generative thinking. This project is based on reality based learning. The whole process is a journey of exploration for the students where a holistic approach to the project is very much encouraged.

Elementary School Technology Education in Taiwan: An Analysis of Implementing Policies

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The 20th century has been characterized by many unprecedented changes in every aspect of life. Education system has been reacted slowest to our rapid changing society. Traditional instructional methods and facilities made us feel awkward when we are dealing with fast global competition. Technology Education may be an alternative to meet this need.

The purpose of this research was to analyze the implementing policies of elementary school technology education in Taiwan. This research reviewed the related literature to answer the following questions: 1) What is the goals of elementary school technology education? 2) What should every child need at the elementary level relate to technology education? Then, 3) considering of the characteristic of learners and the background factors of the whole educational system in Taiwan.

Literature subjects and topics related to the establishment of this study are also discussed in this paper: 1) The Taiwan educational system; 2) Current status of Technology Education at all levels which include formal and informal education; 3) Technological policies at national level; 4) Basic nationalism literacy and technological literacy. In the finding, this study proposed some available policies and the possible implementing strategies.

Current Status of Technology Education at All Levels

For elementary school grade 1 to 2, there is a course of fine arts/craftwork provided 80 minutes per week. For grade 3 to 6, the course is 120 minutes per week. Except the subject of Music, all textbooks include some of the concepts of technological literacy (Lee, 1994). Ni (1995) pointed out that elementary teachers' technology literacy does not meet the requirement.

For junior high school grade 1 to 3, there is a course of industrial arts provided 2 hours per week. There is possible elective course of Industry provided 4–14 hours per week for grade 2 and 12–17 hours for grade 3.Because of the entrance examination of high school, some of the school shifts the hours for Industrial Arts to other courses required for entrance examination. For the same reason, some of the schools assign other course teachers to teach Industrial Arts.

The course of Industrial will shift to Living Technology and reduce half the time. This will happen on 1989.For senior high school grade 1 to 2, there is a course of industrial arts provided 2 hours per week. At his level, students have to pass entrance examination of University to get further study opportunity. The curriculum revised last year (1994).

At secondary level, it is not easy to promote technology education because of the abnormal teaching status.

There is a science and technology museum under construction. This is the place that will offer technology education in the form of informal education next April.

Basic Nationalism Literacy and Technological Literacy

All people have a need to be in control of their lives and to have at least some influence over the people and events around them. Our society structure depends on citizens who have confidence in their ability to make decisions about their own lives, and to influence decisions that are in the best interest of their communities. Basic nationalism literacy should be learned through our compulsory education.

Hamilton (1993) notes that several elements are essential if people are to have control of their lives:

> First, they must have sufficient knowledge. Without knowledge, they cannot analyze the problems, perceive possible solutions, and/or make viable decisions. Second, they must realize that real choices exist. Knowledge without the possibility of genuine choice leads to little action and much frustration. Third, they must want to act. The desire to act derives, in part, from the belief that their choices will make a relevant and desirable impact. (p. 135)

Our Education should be working toward empowering citizens. Doing things without any knowledge are to act irresponsibly. Considering the ubiquitous technology in our society, technological literacy is essential to empowering the citizen.

Society Change and Criteria for Curriculum Innovation

Premier Lien Chan declared" Building Taiwan into an Asia-Pacific Regional Operations Center is a major initiative for economic development by the Republic of China into the next Century". Over four decades, the Republic of China has been bent on developing Taiwan's economy and has achieved marvelous results. The success has brought prosperity to the island and greatly enhanced the country's international status. The secret behind this success is Taiwan's ability to keep pace with the vibrancy of the World and to fashion a stage-by-stage out-ward looking developmental strategy, which has enabled Taiwan to play to its full comparative advantages (EYE, 1995). As the world marches toward the 21st century, Taiwan is faced with a new set of internal and external challenges. In terms of Taiwan's economic structure, its scientific, technological and service industries are replacing the traditional industry in importance.

To meet the challenges at home and abroad, outperform our competitors , sustain the steady development of cross-Straits relations, and find a new international role for Taiwan, government consider the development of Taiwan into an Asia-Pacific regional operations center. According to evaluation by experts, Taiwan is most suited for developing manufacturing, cargo and passenger transportation and professional services. These advantages can be developed by establishing six specific operations centers, namely, the manufacturing, sea transportation, air transportation, financial, telecommunications, and media centers (GIO, 1995). From a educator view point, it is right time to innovate our curriculum for tomorrow's need.

Chung (1991) pointed out that our educational system is facing requirements of specialization, integration, and individualization. He illustrated that "the structure of curriculum is consisted of basic skills, groups of subject-based activities, problem-centered projects and inquires". Curriculum development should meet these criteria.

Characteristics of the Elementary School Technology Education Program

The philosophies of the elementary school must blend with the program. The program should be characterized by the followings:

1. Utilizes the students' natural interests in activities and in manipulating materials and devices as a means for expressing themselves.
2. Ties the curriculum together.
3. Relates information taught in all areas.
4. Reflects the needs and interests of the students.
5. Integrates and reinforces existing curricular concepts through the technological component of our culture.
6. Applications oriented curriculum to complement the following areas: Civics & Ethics, Health Education, Mandarin, Mathematics, Social Studies, Natural Science, Singing & Playing, Physical Education, Fine Arts, Learning Disabilities, Multiple Handicapped, and Interdisciplinary Studies.
7. Proceeds from specific/concrete to general/abstract activities.
8. Implementing through existing elementary classroom teachers or a specialist.
9. Future and problem oriented curriculum.
10. Has high and particular value in the integration of community resources into the education environment.

The content of elementary technology education is integrated with existing subject areas (Figure 1).

T E C H N O L O G I C A L I M P A C T

Technology
Learning
Activities

T E C H N O L O G I C A L I M P A C T

Figure 1 is missing

Figure 1. Technology Education Curriculum Model

The model attempts to communicate how the study of technology relates to the areas of study generally associated with an elementary curriculum. The teacher will want to secure select activities that give relevance to the content.

By concerning the content area of existing subjects, instructional objects for grade 1–2 and grade 3–6 was drawn as followings.

The program for grade 1–2 will provide instruction in technological awareness as a vital force in everyone's life and instruction in life skill development. The instructional objectives are:

1. Compare how technology helps and hurts them and their world.
2. Recognize examples of technology.
3. Differentiate the resources used in technical systems.
4. Recognize standard technological signs and symbols used in society.
5. Show a willingness to risk using new technological materials and tools.
6. Demonstrate how to safely use simple tools.
7. Recognize and identify tools used to satisfy human needs.
8. Describe how to determine whether technology is helpful or harmful.
9. Create solutions to basic needs and wants identified by students and their world.
10. Identify how people use the computer as a tool to communicate.
11. Illustrate how adults use technology in their jobs.
12. Recognize and manipulate simple machines.
13. Illustrate how people use the computers as a general purpose tool of technology.

The program for grade 3–6 will provide following instruction areas:

1. Technology as the application of knowledge to extend human capabilities and to solve problems.
2. Critical thinking and problem solving skills
3. Lifelong learning through technological processes.
4. Societal impacts and consequences of technology on the society and individual.

The instructional objectives for grade 3 to 6 are:

1. Evaluate how technology systems convert raw materials into end products.
2. Contrast examples of the technology growth from historical point of view.
3. Show cooperation in problem solving under group situations.
4. Clarify ways in which technological developments have caused changes in our culture and society.

5. Define and apply the problem-solving model.
6. Explain a technological development by using a systems model.
7. Identify ways that technology will affect our society and how we can be well prepared.
8. Contrast advantages and disadvantages that a factory could have on a community.
9. Assess the advantages and disadvantages of automation.
10. Compare and contrast both positive and negative technologies effects on the quality of life.
11. Apply system model to illustrate the real world example.
12. Evaluate the technology evolving to meet human needs.
13. Evaluate the occupation changes caused by technology.

Conclusion

Technology permeates all societies and cultures. Regardless of their level of sophistication, people created technology to satisfy human needs and desires and to contribute to solving problems.

Technology plays a major role in human lives. It is responsible for the way people live, work, and play. Involving children early on in an action-oriented technology program is the key to achieving a goal of technological literacy.

Technology is always the core around which our daily living evolves. However, it can be misused like any tool or technique. The pollution of our environment and the depletion of natural resources emphasize the extremely important choices in how we use our technology.

The educational system in Taiwan had dramatic progress during last four decade. The economic condition of our society had progress, too. Technology is constantly changing and with it, so are society and environment. Facing all the changes, the curriculum of elementary education should alter so can achieve the goal of our education.

Technology education integrated into the elementary school curriculum promotes an understanding of the dynamic nature of technology by analyzing technological problems, issues, and trends and by engaging in technological problem-solving activities.

The study of technology should be an important aspect of learning at elementary level. It could be taught through an integration of existing subjects. Since technology is an integral part of our lives, weaving the thread of technology through the program of study most closely approximates reality.

Proposed Policies for Implementing Elementary Technology

1. Redefine the subject attribution of technology education.

Traditionally, each subject separates into single curriculum category, such as language arts, social studies, science, mathematics, and fine arts.. For a better placement, we need a new category, technology. Then, we can include computer literacy and environmental study into this new category. Facing the future, this category would tolerate most of the new demand. from our changing world.

2. Set the legal basis of technology learning for elementary level.

Technology education is general education. It could be taught through existing subjects. We need some kind legal basis to promote technology education for everyone and integrate technology into other subjects.

3. Core course movement.

We have to shift current core course from entrance single examination course to integrated courses, so the students could learn through more realistic way. Technology should be considered as part of core course.

4. Prepare teachers for new curriculums.

Technology education requires that teachers are able to know technology, do technology and teach technology. These new demands require both a new type of technology teacher education program and a in-service program for teachers already in the field.

5. Establish the indicator of technology education.

To deal rapid changing technology, we need a indicator system to show the big picture of technology, such as technology distribution, technology in demand, technology, the speed of technology transfer, technology literacy for different levels, and so on.

6. Create a set strategy for promoting technology education.

Although we use technology everyday, the term “technology education“ still new to our society, educational administrators, elementary teachers, and parents. Most adults do not have this kind educational experience. It may be easy to promote since no one had bad experience. On the contrary it may be hard to promote because of wrong message. Anyway, we need careful planned strategies to systematically promote elementary technology education.

The importance of preparing today's students to live and to participate in a technology-based society applies to all students. We have technology education for junior high and senior high levels. Then, we are asking why we don't have technology education for elementary level. "What alliterate citizens should know" will no longer be a major concern. It is not possible to predict exactly the knowledge base required of productive citizens in the service-oriented information age. Technology education is the key for tomorrow's demand.

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The Heart Rate Monitor at School

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The objective of the project still going on is to study the use of the heart rate monitor in teaching. The device has originally been designed for sports training and fitness training, from where its use is spreading to physical education at school. The device provides a many-sided learning environment. By means of this device we obtain information on the heart rate but, in addition, this information can be dealt with in a wider reference frame. In the project described here the pupils familiarize themselves besides with the actual device, the heart rate monitor, also with the functioning of the circulatory system and the respiratory organs and with how physical activities affect the fitness and functioning of these organs.

When seen from this wider reference frame, the project can include several different school subjects. In mathematics we can analyze the data given by the heart rate monitor, tabulate them manually and present them graphically. In biology we can study the functioning of the heart, the circulatory system and the respiratory organs. In physics we can study the fluctuations in the electromagnetic voltage of the heart and the wireless transmission of this fluctuation to a receiver which shows the heart rate measured in beats per minute. In information technology we can explain how the heart rate is registered in the receiver and unpacked from it through interface and computer into a final graph showing the time on the X axis and the number of heart beats per minute on the Y-axis.

The Origin of the Project

The project originated from an idea according to which today's school must cooperate with the surrounding community, especially with industry and trade. The manufacturer of the heart rate monitors, Polar Electro Oy, became one partner in the project. The other partner is the Department of Teacher Education of the

University of Oulu and its Training School. The establishment of cooperation was contributed to by the fact that also the University includes the increasing of its connections with industry and trade among its objectives. Polar Electro Oy again had a product idea which had quickly found a wide market. According to the brochure Polar Electro Oy ”is the world’s leading manufacturer of the heart rate monitoring, registering and evaluation equipment. The company’s products represent the state of the art in heart rate measuring devices for athletic training, fitness and rehabilitation. Polar Electro Oy has undergone a rapid process of internationalization, and isnow the global market leader in its field. The market share of the company’s Polar heart rate monitors is about 80 per cent in the USA, and over 80 percent in Europe, depending on the country in question. Polar Electro Oy’s products are exported to over 30 countries, with exports accounting for 95 per cent of total sales.”

Thus it was natural that the Department of Teacher Education was greatly interested in the significant local high-tech enterprise. As to the University of Oulu, it is a five-faculty university with over 10,000 students. The Department of Teacher Education of its Faculty of Education graduates class teachers. The Department also provides educational studies for subject teachers. When, in addition, the Department of Teacher Education and it straining school have technology education as one of their emphases (cf. Lewis 1992), there was a natural ground for starting cooperation with Polar Electro Oy.

Establishing the Project Group

Because heart rate monitor teaching had not been systematically tested out, at least not in Finnish school education, this became a challenging cooperation project, meeting the objectives of the both partners. For this purpose a project group was established, which had the task to test out heart rate monitor teaching at the Departments training school comprising the grades 1–12 of the general education institution. The project group included representatives of the device manufacturer, and teacher members of the Department of Teacher Education and the training school. Teachers of physical education had naturally a significant role in the group.

Working of the Project Group

The first project meetings were held in spring 1995. The actual work was started in autumn 1995. First the manufacturer arranged training during which the other members of the project group were acquainted with the heart rate monitor and its functioning. The instructor was a representative of the manufacturer. In October of the autumn 1995 an official agreement of cooperation was concluded, in which it was agreed that the project will study the use of the heart rate monitor at school, and prepare the teaching material for it and test it in practice. According to the agreement, the teaching material was to include plans for 15–20 lessons. The teaching plans were to state the objectives, contents and description of the learning process, and the realization of teaching.

We wanted to include also research in the project. It was carried out by two students in the class teacher education programme. Helped by the project group, they had the task of making detailed teaching plans, and to test them in the training school. The results of the tests were to be reported on in a thesis which the students would write for their Master's degree. The result of this decision was that also the supervisor of the students' thesis was included in the project group. Including the thesis in the project made the students aquatint themselves more extensively with i.a. physical education, keeping up of physical fitness by exercise, and previous research on the use of the heart rate monitor.

Teaching Material

The teaching material is composed of two parts. The first part introduces the objectives of teaching and some essential principles of teaching. The objectives are based on pupil activities, individual work and cooperation, and problem-centeredness. When using the heart rate monitor during physical education lessons each pupil obtains information of the functioning of his/her heart (cf. Shephard 1992, Strand & Reeder 1993). This knowledge is increased by describing the heart, the respiratory organs and the circulatory system, and how they function. The treatment of the information given by the heart rate monitor gives various opportunities to explain matters integrated into mathematics, physics and biology. For instance in mathematics we can tabulate the heart rate as a function of time, present the same data graphically and interpret the results verbally. This is possible to be done either manually or by computer. This is thought to contribute to mathematical literacy (cf. e.g. Murray, S. 1995). The data of the heart rate monitor can be registered in a wrist receiver included in the device, and transmitted from it through interface to a computer and presented by means of it in the form of tables or graphs (cf.Johnson 1989). These data can further be processed with some spreadsheet program. During biology lessons we can study besides the functioning of the heart and the respiratory and circulatory organs, also physiological phenomena connected with food consumption and combustion, and thus contribute to scientific literacy (cf. e.g. Driver et al. 1996).

Model Lessons

The model lessons connected with the different subjects have been numbered and their themes are shown in figure 1. This presentation is called the problem circle by the group. It is divided in four different subject sectors and three levels. The problem circle can be read according to the spiral principle clockwise on level I and after that continue on level II again moving clockwise. The same is repeated on level III. The plans of the model lessons have been marked in the problem circle with consecutive numbers (1–16).During each lesson answers are sought for to certain essential issues of heart rate monitor education.

Figure 1 is missing

Figure 1. The essential issues and the main objectives of heart rate monitor education.

The programme of each lesson presents the theme of the lesson, its objectives and what equipment and materials are needed during the lesson. This is followed by a description of the sub-tasks to be carried out during the lesson and the order of their progression. In addition, special aspects and tips concerning teaching are presented. The second part of the material contains additional information for the teacher. It gives information on the heart and its rate and is meant as supplementary material for the teacher. It deals i.a. with the following questions: What is the structure of the heart like, how does it work and which factors affect its functioning? How is the heart rate measured? What is the relation of the heart rate and exercise? Relevant publications and studies (e.g. Armstrong, N. et al. 1991, Boyadjian, N. 1980, Hinson, C. 1994) have been used as references.

The Heart Rate Monitors

The heart rate monitors transmit the heart beat telemetrically (wirelessly). The Polar heart rate monitors are ECG accurate and easy to use. The difference between an ECG and the heart rate monitor is rather simple: the ECG tells the heart beat rhythm and the signals in the form of a graph whereas the heart rate monitor tells the heart beat frequency or the heart rate, measured in beats per minute.

The up-to-date heart rate monitor has three parts: a light-weight transmitter to be attached to the chest, an elastic belt, and a receiver usually carried on the wrist (figure 2).

Figure 2 is missing

Figure 2. The components of the heart rate monitor: the transmitter, the belt and the receiver.

The Polar transmitter is attached to the chest with an elastic belt around the chest. The length of the belt is adjustable according to the width of the chest. The transmitter contains two electrodes which pick up the electrical signals caused by the heart beat on the skin. The transmitter sends the heart rate wirelessly to the wrist monitor using an electromagnetic field. The heart rate (beats/minute) can be continuously read on the display of the wrist monitor.

Using the Heart Rate Monitor

Figure 3 shows the heart rate curve of a 15 years old pupil participating in the project during an exercise period of 1 hours. The duration of the exercise period has been shown on the X-axis. The hours, minutes and seconds are separated by colons. The markings are at half-an-hour intervals. The Y-axis shows the heart rate. We can read on the curve when the heart rate has been above the average. If we set the limit for instance at 150, so the first time the heart rate exceeds this limit is when the pupil has been doing his first warm-up. The next reading above this limit has been achieved in basketball, the next ones after that in football and in indoor bandy. The peak of the heart rate has been reached towards the end of the teaching period when the pupil has been running from end to end of the gym hall, interrupted by squatting down and up jumps. The computer tells that the maximum heart rate of this exercise has been 202.

Figure 3 is missing

Figure 3. The heart rate curve of a 15-year old pupil during a double lesson in physicaleducation.

The Limits of the Heart Rate

The heart rate monitor helps to chart the heart rate limits characteristic for each person in rest and in various forms of activity. These limits are connected with age so that the peak readings of the heart rate are decreased by age. The heart rate of a 20 years old adult at the starting phase of light exercise is 100–120 beats/minute, a heart rate intensity of 50–60 per cent of the maximum. The area suitable for efficient weight loss is 120–140 beats/minute whereby the exercise should last for half an hour and up. Fitness training requires exercise with a heart rate of 140–160 and athletic training exercise with a heart rate of 160–200. All the figures are beats/minute.

According to U.S. studies, a pupil should exercise at least three times a week for 20 minutes with a heart rate that is over 60 per cent of the maximum heart rate (U.S. Public Health Service 1991). Exercising in this area improves for instance the condition of the heart and the circulatory system. The boy observed above had been exercising in the heart rate area exceeding this limit for a greater part of the double lesson.

Conclusion

This article has described the origin of the heart rate monitor project, the teaching material made for the project and the use of the teaching material in the training school of the Department of Teacher Education. The thesis concerning the experiment has been mostly passed unnoticed. This is due to the fact that the thesis is still not completed. On the basis of literature it would seem that when realizing physical education lessons, boundaries will be defined on the one hand concerning the teaching of skills and on the other hand concerning the exercises for physical fitness (Quinn & Strand 1994). The skills can give somebody great pleasure for good performance and thus help him/her to take certain type of exercise continuously. On the other hand one sided concentration on one skill may prevent the overall development of the various components (the strength of the heart and the respiratory organs, muscular strength, muscular endurance and flexibility). When we know that physical fitness and the general state of health are related to each other, especially exercise improving physical fitness is very important. Studies in the USA have shown that for instance pupils weighed more in the 1980’s and they had more body fat than pupils of the same age in the 1960’s (Ross & Pate 1987). It is known that overweight usually is related to a high cholesterol level of the blood and with hypertension which both are risk factors of the coronary disease. Therefore it is not surprising that attention is being paid to physical education at school and it is being discussed how these diseases could be prevented by means of it. The heart rate monitor provides one way to observe the state and condition of the heart and the respiratory organs. It may be possible to prove by longitudinal studies (cf. e.g. Shepherd 1992) whether taking the heart rate monitor to be used at school is one way of increasing the pupils’ interest in taking care of their physical fitness and whether this will affect the general health and well-being of citizens in the future. Maybe the project described here will contribute to this discussion, especially when it proves that the use of the heart rate monitor gives fruitful material to other subjects and may thus motivate pupils to take better care of their own physical fitness.

Descriptors

Technology Education with the Heart Rate Monitor, Integration with other Subjects, Cooperation between a Company and the Department of Teacher education.

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