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The process approach: a dilemma to be faced in the successful implementation of technology in the National Curriculum

George Shield
University of Sunderland

Abstract
The development of process orientated higher order cognitive skills is becoming the most common goal of educationalists in the subject area. This perception of the role of technology education has led to the relegation of ‘technological facts’ and ‘craft skills’ to a much lower status within the hierarchy of aims and objectives. However whilst this understanding has a considerable underpinning in terms of philosophical thought and learning theory the actual practice in our schools may not reflect this priority. This paper looks at this issue through the attempts to introduce National Curriculum Technology in our schools and reasons that the considerable chaos surrounding this implementation arises from a number of inter-related factors such as a confusion of aims and objectives, the unfortunate translation of models for ‘technology’ and ‘design’ into teaching and learning strategies, and insufficient and impractical guidance from published guidelines. The paper suggests that whilst the revision of the statutory orders is an improvement, the way forward must be based upon a programme of empirical research which may help to rationalise the gap which exists between rhetoric and practice in delivering technology education in our schools. Such research should reflect professional practice and also recognise the sufficiency of the existing resource base. The discussion is based upon a review of recent literature, including research reports, as well as the author’s qualitative study of the practice of technology in eight secondary schools in the north east of England.

The Education Reform Act¹ included Technology as one of the compulsory foundation subjects in the state education system for the first time in history. Since this declaration of intent however, the pictures to emerge from attempts at implementing this resolution have shown, at best, confusion and at worst chaos²³. The subject has become a focus for conflict between “traditionalists” and “progressives”, between the various factions representing the contributing subject areas and between those groups whose interests lie elsewhere, for example in gender issues or vocationalism.

Any understanding of the agenda of the ‘new right’ that emerged in the 1980’s would have suggested that ‘knowledge’ and ‘skills’ would dominate the National Curriculum allowing for ‘objective’ standards to be assessed⁴. However with the publication of the National Curriculum Statutory Orders⁵, and further guidance in 1992⁶ there emerged a ‘new’ subject called Technology⁷ that even the most liberal educationist would have found difficult to fault. It embraced concepts such as ‘relevance’, learning through discovery, the relegation of ‘facts’ and ‘craft’ skills to a position of almost total obscurity, and encouraged the integration of traditional subject areas to promote a ‘holistic’ experience. It was also said to encourage the development of higher order learning skills through the enhancement of ‘process’ concepts. The development of strategies to solve problems became more important than factual content⁸.

The initial expectations in 1990 of what was to be offered, whilst welcomed by some, were also tinged with a little scepticism⁹ and it is perhaps this scepticism which has proved to be the most prophetic.

Current documentation¹⁰, whilst rationalising the demands made on children and their
teachers, has failed to provide a rationale for the choice of ‘knowledge and understanding’ components of the standing orders and to recognise the complexities of the cognitive elements in ‘designing’. This superficiality of approach has sown the seeds for the development of a subject area lacking rigour and consequently credibility.

The difficulty of composing a statement that describes the subject area has still not been reconciled consequently a sufficient philosophy to place what is being advocated within the school curriculum has not been formulated or expressed. What must be assumed, therefore, through an extrapolation from other writings in the subject area, earlier versions of the Statutory Orders and reference to design and make assignments in the current orders10 is that ‘technology’ is still bound within the context of a process methodology. (Although this assumption can no longer be made with quite so much confidence as ‘practical tasks’ and ‘activities’ also feature prominently in the latest orders.)

Views that emphasise the role of ‘process’ within technology education are not new7. They have, however, become more marked with the implementation of the National Curriculum and they have contributed to the polarisation of the ‘process’ v ‘product’ debate.

What is apparently at the heart of thinking in technology education, both in the National Curriculum and in the writings of the mainstream thinkers in the field, is the perceived need to emphasise the acquisition of the higher order concepts6 needed to equip our children with the skills and knowledge thought necessary to cope with their increasingly problematic future caused by technological advance11. These requirements accompany the need to understand the social and moral dilemmas inherent in these advances12,11.

This child centred understanding has increasingly coincided with more utilitarian or instrumental demands. The debate on the need to ensure that the country has a workforce that enables it to meet industrial competition is still being argued and the government is continuously being exhorted to provide the resources and encouragement necessary14; 15; 16. This demand to provide a suitably educated (trained?) workforce is accompanied by the requirement that the most able children are to be attracted to work in business and industry7; 18; 19, to provide both leadership and the necessary intellectual ability to meet the full range of these new demands.

This understanding of the worth of technology is recognised internationally and is possibly the major reason for its increasing popularity throughout the world20; 21; 22; 23.

It must be emphasised however that whilst the popularity of the subject is expanding internationally, what is understood by the term is not uniform. Considerable variations are evident on the emphasis to be placed24 in its content base. Nevertheless the primacy of higher order learning through a process approach is being increasingly advocated by many developed as well as developing countries.

Whilst the current ‘process driven’ philosophy of design and technology is based upon logical thought and educational principles developed in good faith, its current pre-eminence is attributable more to the increasing volume of rhetoric than empirical evidence gained from structured research.

I suspect that many colleagues, whilst being strongly attracted to the philosophies that have gained prominence over the last two or three decades are now beginning to question these received wisdoms. However, whilst there are question marks placed against current practice it is also apparent that much good work is being carried out in our schools. What is of paramount interest, therefore, is how good teachers of technology perform their role in the classroom and possibly through a study of such good practice, how their pupils learn.

The purpose of this paper is to indicate, through reference to my own, and the research of others, some pointers which may
identify features of the complex role of the technology teacher which will help us to understand how more effective strategies can be developed.

The first point to emerge from my research which, looked at the work of some twenty technology teachers, was that whilst the type of activity taking place is frequently described as ‘problem-solving’ or ‘design oriented’ the practice of both teachers and their pupils was heavily qualified by other considerations. In a number of cases the activities being carried out by the pupils were so circumscribed by restrictions placed upon them by the teacher that the children were in effect working to closely structured briefs, or being ‘guided’ by the teacher to produce variations on pre-ordained solutions. In some cases the teacher does allow for some degree of pupil involvement but this was generally restricted to minor inputs in the shape and decoration of an artefact or sometimes in the ‘packaging’ of an electronic circuit.

These findings are in some way corroborated by the work of Jeffrey25, Heywood17 and also Chidgey26. Research in New Zealand27 has likewise shown that despite using a process approach there was a focusing by students on an end product which in effect side stepped the asking of appropriate questions or even using suitable strategies and skills.

Whilst these findings could suggest a practice which is unacceptable in terms of current philosophies, I suspect that teachers at ‘the chalk face’ are in effect translating an educational ‘ideal’ into a practical or workable teaching strategy. This grass roots approach to the problems which are faced by the teacher should not however be condemned as poor practice, as it is now being increasingly supported by empirical evidence as a valuable procedure.

Some authorities, for example McCormick and Murphy28, are claiming that some of the problem solving concepts which are a central theme of technology education are very difficult to enhance using methods which are currently employed. They particularly questioned the strategy of providing knowledge on a ‘need to know basis’ and also the effectiveness of a generalised problem strategy for technology. Similar criticisms are expressed in other areas of the curriculum such as science29, and mathematics30.

A further influencing factor on the methodology employed by teachers has been said to be the problems associated with the assessment and evaluation of pupils performance, and in these days of accountability, the performance of their teachers.

Eisner32 has urged that this issue needs to be addressed urgently as the strategy of assessing outcomes of design and make tasks tells us nothing about the child’s approach to problem solving, and it is an analysis of the approach that could lead to the modification of the child’s performance not an evaluation of a finished product. This problem was also recognised by Kimbell et al.33 in the APU report on assessment of performance in the subject area. This domination of design and make activity by assessment procedures is particularly unfortunate as the ‘design’ model in common use was never devised to illustrate either a teaching and learning activity or a strategy for assessment34.

The results of the design approach which has been adopted within the technology areas of many of our schools could be said to be a narrowly perceived understanding of designing rather than the source of the generalised higher level skills which are claimed to stem from it. A new orthodoxy could be developing in which the major emphasis is placed on following mechanical strategies or processes rather than more desirable objectives. The results of this approach could rival much of the low level activity that preceded it under the traditional and outmoded subject titles of pre National Curriculum programmes as an insufficient use of the educational process31.

How can this position be remedied?

If it can be assumed that the predominant activity of the acquisition of ‘facts’ is an insufficient aim for the subject area it is essential that other strategies and abilities are
developed which will allow children to enhance their capacity to meet the stated goals of being able to rearrange and interrelate available data to meet new situations or solve problems. Work by McCormick et al.31 has suggested that an emphasis must be placed on getting beneath the ‘veneer’ of the algorithmic approach to problem solving to ensure that understanding of the various components of a design approach is enhanced through a concentration on the nature of these abstract concepts rather than on the ritual following of a mechanistic design strategy.

Underbakke et al.35 have also arrived at similar conclusions and they suggest that specific types of classroom experiences should be devised which give the children experience in particular activities such as hypothesising and testing, assessing arguments, solving interpersonal problems, probabilistic thinking and developing and maintaining flexibility and student awareness.

Some of the teachers in my study did attempt this broad based strategy but they were also aware of the requirement to provide ‘evidence’ of the sub-processes for evaluation purposes, consequently the production of a well-presented ‘folio’ claimed precedence over understanding.

These teachers were also adept at enhancing the subject knowledge and skill base of their students and through this strategy equipping them with the ability to solve problems. In employing this tactic teachers may simply be applying, unconsciously, the findings of Glasser 36 whose work suggested that in both experts and novices alike problem solving difficulties can be attributed to inadequacies in their knowledge base and not their inability to use problem solving heuristics. These research findings are backed up, in practical terms, by the curriculum development project funded by the Nuffield Foundation 37 in which two types of learning activity are suggested, resource tasks and capability tasks both of which contribute to technological capability. The National Curriculum is also moving towards this way of thinking with its focused tasks and activities9.

There is however much more to teaching than passing on technological information and/or ‘design skills’ in a didactic manner - the teacher’s role is highly complex. Some of the teachers in my research were noted to be, at various times, motivating, cajoling and encouraging, passing on information by instruction and teasing out understanding through questioning. They were also facilitating this learning by directing children to sources of information, by providing specific help for the child to carry out a process and by providing tools, equipment and materials at appropriate times. All of this is conducted within a framework of ‘good order’38.

This wide range of skills is part of the ‘craft’ of the teacher and as such they are difficult to separate in terms of their significance.

It was also seen to be important for the learning activity of the child, that the ‘whole’ was a seamless activity and that the child was purposefully engaged in the learning activity. This is often translated into a project approach which relies heavily on one to one instruction. Individualised design and make strategies, particularly if taken to extremes, can however mitigate against effective teaching. For example it is common practice for teachers to conduct demonstrations and ‘whole group’ teaching sessions to cover what are thought to be issues relevant to the work of all of the group.

When children are engaged in individual projects however the opportunity to make these demonstrations relate to their work in hand is diminished and teachers become involved in a process of repeating the same demonstration at the appropriate time for each child ‘as required’.

I am not however advocating abandoning the individual project as a learning medium. There are considerable advantages claimed for this individual approach For example, some learning theorists point to the employment of strategies which can be explained in terms of socio-cultural theories of psychological
development in which learning takes place through interaction with others, both peers and teachers\(^{38-40}\).

The need for the teacher to help children over the boundaries of the ‘zone of proximal development’\(^{41}\) has parallels in methods adopted during ‘apprenticeship training’, well known in the traditional fields of technology and craft training. In the practice of process methodology in which the teacher works closely with the child in the development of his or her ideas there are echoes of this apprenticeship model. With the timing, quality and quantity of the teacher interaction varying according to the needs of the pupils, the ‘scaffolding’ of the learning experience varies to suit the needs of the children at that stage of their development\(^{41}\).

Lave and Wenger\(^{41}\) have described as ‘legitimate peripheral participation’ the process whereby learners and teachers both learn through the interaction that takes place in the social setting of the classroom\(^{42}\). This concept of situated learning suggests that an understanding of facts requires more than the ‘receiving’ of information but also entails an interaction between the environment (in its broadest sense) and the learner\(^{43}\). Clayden et al.\(^{44}\) have also used this understanding and support the theory with their view that insights ought to be given into the practice of practitioners, e.g. designers, rather than into the practice of ‘schooling’ itself. They further elaborate the understanding that learning is a product of negotiation, a constant initiation into ‘socially constructed webs of beliefs’ (p.166) thus requiring much more than the transmission of knowledge. Obviously, the enhancement of higher order learning is not solely dependent upon social interaction, the additional dimension of the individual’s cognitive makeup\(^{45}\) is also important in the development of technological concepts.

With the increased freedom of choice of project offered to the child the role of the teacher as facilitator, often at a very low level, e.g. providing materials, becomes increasingly time consuming to the detriment of the teacher’s role as a skilled mentor. In other words there is a conflict between the time required and that which is available to the teacher for enhancing understanding on a one to one basis demanded by the project approach.

The cycle of learning activities that take place throughout the design and make process of the technology lesson places an emphasis on the role the teacher plays during the complete period of the topic or the manufacture of the artefact. If the project is introduced through the application of the technology algorithm that is in general acceptance, i.e. identify a need, generate a design, plan and make the artefact and evaluate the product, the teachers input and the children’s learning activities vary as the child moves through the process. That is, the nature of the teacher/pupil interaction changes as the lesson progresses. Whatever happens, however, the actions of the teacher should focus upon the ‘learning’ of the child rather than on the peripheral activities of technician or ‘box ticker’, important though these are. The opportunities that are presented through the assessment arrangements of the new orders, which are not available at the time of writing, will be more indicative of the nature of the activity than either a syllabus or programme of study.

In summary, therefore, we can see that teachers when confronted by a mixed group of children in the classroom face a number of dilemmas or conflicts, such as reconciling the development of ‘process skills’ with the production of a ‘folio’ as evidence for assessment, trying to balance ‘freedom of choice’ and student selection of a brief with covering a body of knowledge to ensure understanding and balancing a ‘holistic’ design approach within a limited resource base. Perhaps the time has arrived whereby we jettison either the more esoteric goals we aspire to, on the grounds of practicality or remove the ‘knowledge base’ completely and concentrate on the more general cognitive skills we say we are encouraging. What has become clear is that to date a considerable degree of self deception has occurred which is only slowly emerging and which, if not challenged, will become self destructive. What we may be about is ‘knowing and applying’ rather than ‘designing and making’. A subtle
change within school technology may be a more realistic goal to aim for and a goal that can only be given authority with the backing of well-founded research.

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46 Board of Education *Hand book of Suggestions for Teachers.* HMSO. London. (1929)

a In a pamphlet published by the Centre for Policy Studies, Taylor recommended that the National Curriculum should consist of:

i) a basic core of knowledge and skills which all pupils should be taught.

ii) objective standards of attainment across the curriculum....

iii) standardised systems of assessment whereby reliable comparisons can be made.

b The 1929 edition of the *Handbook of Suggestions for Teachers* has a chapter on ‘Handwork’ in which many of the current debates are discussed, including the opportunity for ‘intellectual benefit’ to be obtained through ‘boys designing and planning’ for themselves.

c Higher order concepts for the purpose of this work are taken to mean those concepts which require the student to interpret, manipulate and analyse data. Whereas those of a ‘lower order’ are those which can be acquired from the mechanistic application of knowledge gained previously.

d Learning theorists would point to the place of the short term memory store in an information processing model for an explanation here. i.e. if the child can not consolidate the information quickly it may become lost and not therefore transmitted to a long term store.