A critical analysis of the operational aims and objectives for technology for 14 to 16 year olds in England and Wales

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Abstract
This paper analyses published aims and objectives for Technology for 14 to 16 year olds from two sources. The sources are:

the Statutory Orders for Technology;
General Certificate of Secondary Education (GCSE) syllabuses

The analysis will focus on such concepts as breadth, depth, progression, balance, differentiation and relevance. The implications of the aims and objectives for classroom teaching and learning strategies, resource provision and student assessment will be identified and discussed. The overall objective will be to identify areas of commonality and areas of difference within the documents analysed.

In their attempts to promote discussion about the curriculum, HMI published a series of documents under the general title "Curriculum Matters", and in "Curriculum Matters 2" (1985)[1] sought to stimulate discussion about the whole curriculum. In this document HMI summarised and reflected the emerging mood within education and provided the bye-laws for curriculum design which are now embedded in the National Curriculum and which are based on the concepts of breadth, depth, balance, differentiation, relevance and progression. These concepts apply as much to the design of the curriculum of individual subjects as they do a whole school curriculum.

In considering the design of the Design and Technology curriculum we reviewed the debate set out by the Schools Council (1971)[2], HMI/DES (1977[3], 1980[4], 1981[5], 1981a[6], 1984[7], 1985[8], 1988[9], 1989[10]), the deliberations of the Design and Technology Working Group (DES 1988[11], 1989[12]) and the non-statutory guidance provided by the National Curriculum Council (1990)[13] and the Curriculum Council for Wales (CCW) (1990[14]). From this literature review we constructed a series of questions which became a framework for our analysis and discussion of Design and Technology as set out in the Orders (1990[15]) and in GCSE syllabuses.

Analysis

It can be argued that the National Curriculum for Technology meets in its Programmes of Study and Attainment Targets each of the concepts noted above. Breadth is taken care of through the contexts used to deliver Design and Technology. Balance is incorporated through the contexts and through different disciplines which contribute to the overall subject. Relevance should also be present in all work carried out. The reality, however, is that much depends on individual teachers and how they deliver the subject. Differentiation is provided through the levels of attainment. Furthermore, the model of Attainment Targets adopted tends to reflect a linear reductionist model of pupil learning which does not mirror the way pupils learn. We return to this later.

An examination of progression highlights a number of difficulties to be considered. Our analysis of the Programmes of Study led us to break these down into strands which are readily identifiable by teachers of these subjects contributing to Design and Technology as parts they are able to teach. The strands which we have identified as making up the Programmes of Study are:

systems;
mechanisms;
structures;
drawing;
modelling;
economics;
energy;
environment;
evaluating;
talking;
communicating;
materials;
safety;
aesthetics;
historical/cultural;
developing.

Perhaps not all of these strands are acceptable to all

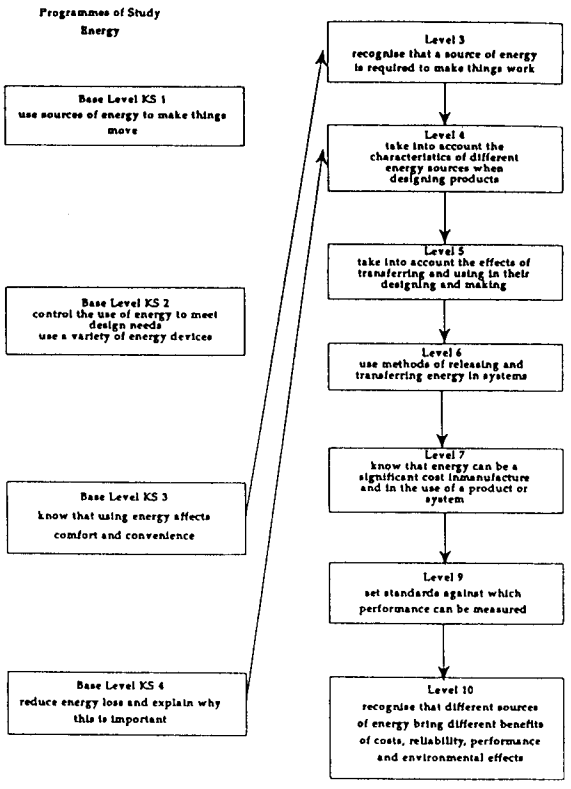

fig 1

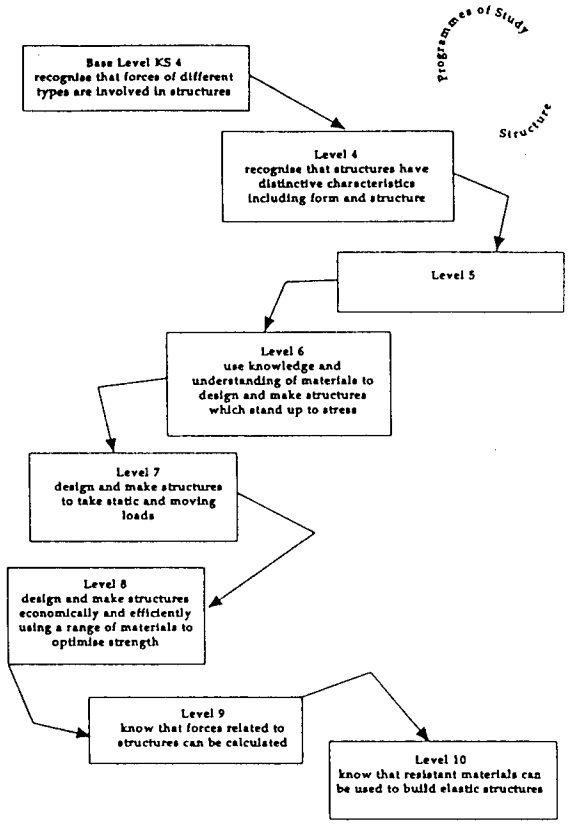

fig 2

teachers, but they can all be found to a greater or lesser degree within the Programmes of Study. Tracking these strands through the Programmes of Study enables an analysis to be carried out.

* In some strands there are discontinuities in the statements between levels. For instance, in the energy strand, there is no statement for level 8: in the structures strand there is no level 5. This in itself is not a major problem. Some examination boards, for subjects other than design and technology, are making up statements for levels which do not have their own, or are omitting to put levels on the statements.

* Accepting that Key Stage 4 has levels from 4 to 10, the base entry levels to the key stage has statements which are more complex and require a higher degree of conceptual and cognitive ability than the lowest level in the appropriate key stage. For example, in systems the base level statement is:

> *"estimate the operating costs of a system, its dependency on other systems and evaluate its efficiency."*[16]

When this is put against level 4 statements about systems, it can be seen that any pupil attaining the base level has already got much further than level 4.

> *"know that systems have inputs, processes and outputs and recognise these in a variety of simple systems."*[17]

* Still dealing with base level statements, some are so broad that it is unreasonable to expect any pupil to attain to any significant level of understanding. An example of this is with the environment strand, which states that pupils should:

> *"recognise the social, moral and environmental effects of technology"*[18]

* There appears to be a trend for progression to be considered as an increase in difficulty as pupils go through the levels, as pupils move into more unfamiliar contexts or become more sophisticated in more familiar contexts, but the reflective capability of the pupil is not considered to any great extent, in either the Programmes of Study or the Attainment Targets.

* There is not always continuity of progression within a strand to enable teachers easily to devise schemes of work to give a progressive flow. The statements themselves are sometimes isolated, not providing continuity, even when there are no missing statements. For instance, in the mechanisms strand:

"know that mechanisms can be controlled within electrical, pneumatic and fluid systems, and can be controlled through computer and interface devices"
(level 8)

"design and make efficient mechanisms using the minimum quantities of materials and components"
(level 9)

There is no level 10 statement.

* There is much mention of recording and reporting within the programmes of study.

* Some strands do not have any levels of attainment above level 8. As an example, energy is not mentioned above this level. The only mention at level 8 is statement (a) in AT4:

"8a) present an evaluation of their activities, including suggestions for improvements, and a discussion of:

(i) the relationship between the materials chosen and the procedures, techniques and processes used;

…(iv) an estimate of the effects and consequences, including environmental and economic ones." [19]

This statement can have a variety of interpretations. It does not immediately stand out as being one which mainly deals with energy considerations. It is the only one which could possibly include such a requirement. The example quoted alongside it does not look at energy considerations:

"Evaluate an automatic camera activating trigger they have designed and made as a means of detecting and photographing wildlife" [20]

* The levels of attainment and the statements in the Programmes of Study are also very confusing as they are almost without exception multi-statements.

* Similar statements in the Attainment Targets do not appear to differentiate very much between levels. For instance:

"collate, sort, analyse, interpret and present information in a form appropriate to the purpose and the intended audience"
(level 5)

"collate, sort, analyse, interpret and present information in a logical and coherent way"
(level 6)

If you are giving information to an audience, it must surely be presented in a logical and coherent way. What seems to be lacking are the criteria which will discriminate between the levels, criteria which are not only terminologically distinguishable, but also refer to observable features in the design and technological performances of the pupils' concerned.[21]

* The Attainment Targets are indicative measures of the capability of an individual pupil to grasp the processes of designing and making, whilst the Programmes of Study are an attempt to describe for the same pupil, the necessary skills, knowledge, attitudes and values which facilitate the activity.

Discussion

Some consider that Design and Technology should be seen as a holistic activity. (as Hicks, 1991) In order to achieve this, the Attainment Targets need to be considered as integrated. It is unfortunate that its constituent processes, which they reflect, have been isolated, perhaps randomly, into discrete units which inhibit pupils from designing and making in a natural manner. Pupils are required to meet legal requirements of the Attainment Targets which actively inhibit these processes. Some teachers feel that they must teach to these Attainment Targets instead of the Programmes of Study.

The Programmes of Study describe the skills, knowledge, attitudes and values to be included in a meaningful scheme of work for pupils. However, the Attainment Targets go in a different direction, are concerned with assessing the processes of designing and making. This presents a possible conflict for teachers as to whether they should teach to the Programmes of Study or the Attainment Targets. This applies to the current versions of examination syllabuses, which are required to use the levels of attainment taken from the Standing Order as a marking scheme.

What should be said is that those teachers who teach to the Attainment Targets will not engage the holistic approach to the subject that is required. The processes in which pupils are engaged in their designing and making are signalled quite clearly by the Attainment Targets, but it would be contrary to good practice to apply a reductionist view to the subject by teaching just to them. The pupils will not gain by the experience. Their learning would

become very narrow, making Design and Technology into a competences-based subject - a set of "can do's" - and consequently the relevance of their learning would be significantly diminished, making it into a "so what?" subject.

Given the holistic nature of the activity, when one is designing one is constantly evaluating from the moment of first identifying a need or opportunity to the evaluation of the finished product. The Attainment Targets go against this and try to linearise the process. In so doing they inhibit "good" design practice. There is a mismatch between the Programmes of Study and the Attainment Targets since one is attempting to give pupils a range of activities to broaden and enrich learning while the other is a poor attempt at representing a process which must be taken as a whole to have any real meaning. Teachers who insist that pupils meet AT1 at the start of every Design and Technology activity may erect a hurdle which inhibits pupils' further learning and development. As Hicks (1991)[22] stated, it is not necessary to reach all of the Attainment Targets every time. As long as the whole process is covered once in a key stage, it should be enough. Pupils' progression will be inhibited unless they are taught appropriate skills and knowledge. These can be "lost" if taught continuously inside a context. Sometimes it is important to step outside the context and teach a skill or aspect of knowledge. This would enrich more open-ended tasks which could follow.

Design and Technology is about enriching life and the appropriateness of solutions. Opportunities for pupils to consider attitudes towards a range of solutions to a problem and the value systems which inform and determine those attitudes are an integral part of design and technology.

The sheer weight of working in at least five contexts in each of the key stages is difficult enough, and added to that the broad range of subject contributors to Design and Technology is a recipe for disaster. Even if each of the contributors to Design and Technology is physically situated next to one other, the co-ordination of activities is a nightmare - who covers what, where, when and how? Many schools have CDT, HE, Art and Design, Business Studies departments situated in areas of the school which are not easily accessible from each other. This then inhibits the methods by which the subject can be delivered, and so reduces the effect of the subject on pupils.

In examining the Programmes of Study, which provide the basis for schools' schemes of work, there seems to be a lack of coherence. There are areas of the Programmes of Study which do not allow a systematic building on previous knowledge, skills or attitudes, due to a lack of continuity of statements within the programmes of study. The use of prior knowledge in building up the experiences of pupils is an essential feature of any course. There is no specific provision for this within the Orders for technology; it is left to the school to incorporate in its schemes of work.

The base level statements in the Programmes of Study do not work in favour of the 'weaker' pupils. In many cases, the pupil attaining the base level for Key Stage 4 has already got to level 6 or 7. This seems to defeat the purpose of the range of levels for Key Stage 4 stretching from 4 to 10. GCSE examination syllabuses appear to ignore base level statements and just use the statements from levels 4 to 10.

The breadth of some base level statements makes life very difficult for the teacher, who then has to make judgements about each of her or his pupils, which could, and probably will, be different from other teachers. Taking as an example the statement about recognising the social, moral and environmental effects of technology, no teacher can get a pupil onto the levels of attainment in key stage 4 with a statement like this one. Some people spend most of their lives discovering and investigating these effects of technology. Accepting that this is only one of many statements does not help very much.

In order to satisfy the criteria a pupil should, according to the Standing Orders, meet each statement. This is very difficult for pupils to achieve, and even harder for teachers to devise schemes of work to achieve that objective. The complexity of most of the levels with their multi-statements makes for a very unmanageable state. It is possible to cover statements from the same element of the Programmes of Study within different subjects, but it is very difficult to keep track of what is happening with individual pupils.

The structure of the National Curriculum is such that there should be no discrepancies or discontinuities between phases. This is not always a manageable thing as the Orders leave a great deal of scope for individual schools to interpret. The Orders are necessarily very broad, because technology deals with those problems and issues which society has to face. This creates concern in some secondary schools, producing schemes of work in Key Stage 3 such as assuming that all pupils are, say, at level 3. This type of approach can cause disillusionment among pupils who have attained higher levels than level 3. This also has a de-

motivating effect on pupils.

The Orders allow for progression between projects but it is once again up to teachers to provide this. Usually, on a day to day basis, there should be no excuse for not providing continuity. Problems could occur between the contributing subjects, but this is a management difficulty.

The pressure of all the Programmes of Study and Attainment Targets can and does in many instances rule out quality of manufacture. One tenet of CDT in the past was that its practitioners were rightly proud of the high level of skills taught to and practised by pupils engaged in activities of making. Accepting that the view of designing was more limited than that in the National Curriculum, it is still very appropriate to encourage pupils to have pride in their making work. Undoubtedly, a key motivation behind technology for all from 5 - 16 is the view that competent technologists are vital to Britain's industrial future. However, we should not lose sight of the benefits to pupils in Design and Technology for its own sake, for pleasure and the satisfaction of making something, appreciating other cultures and ways of doing things, etc.

Conclusion

In recent weeks, the Secretary of State for Education has announced a review of the Orders for Technology. It is to be hoped that the review team have themselves identified the areas of the Programmes of Study which are causing conflict, and can resolve them into a workable scheme. At the same time perhaps the Attainment Targets can be rationalised into one, which encompasses the processes of designing and making and at the same time incorporate statements which correspond more closely to those in the Programmes of Study.

We consider that the Orders should be clarified in order that teachers can make realistic and sensible decisions regarding their schemes of work. By this we do not mean that the Orders should be written in simplistic terms, which is insulting to a highly intelligent and skilled body of people, as is implied in the NCC document "National Curriculum Technology: The Case for Revising the Order"[23] which states in para 15:

> " ... even at secondary level, the intellectual demands of the Order present a challenge to teachers of traditional Craft, Design and Technology, who tended in the past, to emphasise the development of practical skills."

The intellectual challenge should be there, but what is to be achieved should be stated clearly and unambiguously, and the unnecessary complexity of multi-statements and non-corresponding Attainment Targets should be resolved.

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