1. WHAT DOES THIS BOOKLET OFFER?

The need to increase the level of technological literacy in all societies is of international importance. The inclusion of Design and Technologies and Digital Technologies as a learning area in schools is part of a worldwide trend and school programmes are including technology as an essential part of every student's education. With the move to include Design and Technologies and Digital Technologies in school programmes there are many initiatives for suggesting ways in which teachers should do this. There is no shortage of advice and encouragement for teachers to improve their work, to raise their standards and to improve student learning. However, all too often, the enthusiasm of the proponents of such initiatives is not matched by evidence that the initiatives will be either feasible, or effective, in practice.

This booklet offers advice to teachers on how to interact more effectively with students, on a day-to-day basis, promoting their learning. What is offered is backed by rigorous evidence that the initiatives proposed do actually improve students' learning achievements in technology. Whilst this booklet contains ideas that have worked for other teachers, we emphasise that formative assessment is considerably more than the sum of a series of handy tips and techniques. Hence, what we offer here is an approach for the thinking teacher to use in guiding their practice. The specific aim here is the improvement of learning in Design and Technologies and Digital Technologies.

In section 2 of this booklet we set out the background to formative assessment. In section 3 these ideas are put in the context of the aims and expectations of design and technology teaching. The recommendations we make gain particular strength from the fact that they are grounded in the main findings of many decades of research into the principles that govern effective learning and the factors that help support the motivation and self-esteem of learners. These foundations for formative work are discussed in section 4.

Sections 5 to 9 set out in detail our findings on ways of practising formative assessment in design and technology, which we have found to be both workable and productive with teachers. These are organised around the following themes:

- *planning to promote learning;*
- *classroom dialogue;*
- *feedback;*

- *peer and self-assessment;*
- *formative use of summative assessment.*

Finally, in sections 10 and 11, we discuss implementing a departmental approach to implementation and advice for promoting assessment for learning within the school.

2. BACKGROUND HISTORY

The findings on which this booklet is based have their origin in a review of research, published in 1998 both as a full article and in summary form as a short booklet for teachers (Black & Dylan, 1998; Black & Wiliam, 1998). This work established that there was strong evidence that formative assessment can raise standards of student achievement, but that the assessment practices entailed were not implemented in most classrooms. This led the group at King's College London to explore the potential for practical improvement by collaborating with a group of teachers willing to take on the risks and extra work involved, with support from their schools and their LEAs. At the same time between 1998 and 2000, researchers at the Centre for Science and Technology Education Research (CSTER) at the University of Waikato, in New Zealand, were also collaborating with teachers to explore the potential for practical improvement of formative assessment in technology classrooms. Thirteen year 1 to year 8 teachers were recruited from five schools, spanning a range of catchment backgrounds to begin the Learning in Technology Education (Assessment) Project (LITE). Another three-year project began in 2005 – the Interactions in Science and Technology Education (InSiTE) Project, where ten year 1 to year 8 teachers from seven schools are involved in further explorations of formative assessment in science and technology classrooms.

The first outcomes of formative assessment undertaken by the King's College group were that almost all of the teachers were positive about its effects for them, and that there were significant gains in the test performance for the classes involved. The findings were summarised in a booklet for teachers (Black *et al*., 2002) and reported at length in a book (Black *et al*., 2003) and in many papers in professional and research journals.

The outcomes of the two CSTER group projects mirrored the King's College outcomes in that all the teachers were positive about its effects for them, and there were significant gains in technology learning outcomes for their classes. On the basis of classroom observations by the CSTER team, records of meetings of the whole group of teachers, interviews with and writing by the teachers themselves, student interviews, and the examination of students and teacher work, the team were able to summarise the findings in professional and research papers and to make numerous contributions to teachers' conferences and to school and in-service training.

In England, assessment for learning practices in design and technology arose from a different starting point than in New Zealand, beginning with radical curriculum change. In the late 1980s, the Assessment of Performance Unit (APU) posited a model of interaction between mind and hand as a new framework for assessment in design and technology (Kimbell *et al.*, 1991). In assessing the design skills, it emphasised the thinking and decision-making 'process' that results in products rather than products that result from the processes. To assess this intellectual process, a number of strategies were developed to encourage students to make their intention explicit in action on a paper-based design and technology task.

However, the work of the APU did not have significant influence on the assessment model developed by examining bodies for GCSE project work in design and technology. Atkinson (2000) scrutinised the project work of fifty 15-year-old students from eight schools in the north east of England. Her study revealed that teachers, in responding to the GCSE guidelines, engaged students with 'highly structured, inflexible procedures which prevented rather than developed creative, innovative thinking' (p. 276). Teacher assessors rewarded ' "thin" evidence that is well presented rather than rewarding the use of higher order skills, in particular creative thinking and appropriate design processes' (p. 277).

In response to this dire situation, the Innovating Assessment Project (Kimbell, 2005) has explored ways in which creative behaviour in designing can be revealed and assessed. The focus has therefore concentrated on the summative end of the assessment spectrum. It has been in the work of curriculum development projects that attempts have been made to explore the role of assessment for learning and to develop methods by which this can be integrated into classroom pedagogy. Three curriculum development projects that have deliberately explored the role of assessment for learning are the *Nuffield Design and Technology Project*, *Young Foresight* and *Electronics in Schools*. Each of these has been the subject of independent external evaluations that have identified the key role that can be played by formative assessment and helped refine the methods by which it can be achieved. Throughout this work, all groups were aware that formative assessment has both *generic* features, i.e. features that apply to learning across all stages and all school subjects, and features that are *specific* to particular subjects, or to students of particular ages. In this booklet, we focus on technology teaching with examples drawn from both primary and secondary sectors.

3. AIMS OF TECHNOLOGY TEACHING

Technology education is a compulsory subject for many students throughout the world. The current focus of attention in technology education is towards technological literacy for all. Students need to experience and explore a wide range of technologies in a variety of contexts in our human-built world to develop technological literacy. This will enable them to participate in society as informed citizens.

While curricular changes may affect the approach that teachers take to technology, the fundamental ideas that we try to convey to learners are the same. People use technology to expand their possibilities, to intervene in the world through the development of products, systems and environments. To do this, intellectual and practical resources are applied. Technology includes control, food, communications, structural, bio-related, materials, and creative design processes. So when students attempt such activities as designing furniture, their studies in technology are more than just mental exercises. They identify and define the problem. They generate several ideas for a solution, working within constraints. They often work in teams when building models of their design plans. They may drop the original design and try another. Through several iterations they choose a final design and they may build a working prototype. They will learn about the most appropriate materials and the most effective structure for their furniture.

In technology disciplines, as in other subjects, students are expected to acquire knowledge, skill and understanding. But the story does not end there. It is also in the **application** of this knowledge, skill and understanding that their ability in design and technology is revealed. The situation is complicated in four ways.

First, there is the usefulness of the knowledge. It is important that students can identify knowledge that is useful to the design task in hand. It really doesn't matter how much a student knows if he or she can't decide what is useful for the task. Different knowledge may be required for different design solutions.

Second, there is the source of the knowledge. In some cases useful knowledge will not come from that which is taught in Design and Technologies and Digital Technologies lessons or in other school subjects. This is particularly true for *knowledge of the problem* being tackled as opposed to *knowledge for the solution.* For example, knowing about the preferences of the intended users of a product to be designed is something that almost certainly cannot be taught or is available to be 'looked up'. It is knowledge that students have to acquire for themselves through observation, questioning and speculation.

Third, there is the extent of the knowledge that is required. Just how much does the student need to know in order to be able apply the knowledge successfully? For example, understanding an explanation of the properties of materials is not necessary in deciding which material to use for a particular application. Understanding the concept of 'material property' is essential; e.g. what are density, hardness, strength and stiffness? But being able to explain why a material has particular properties is less important here. Matching performance characteristics to performance requirements is the required skill.

Fourth, there is the requirement for some creativity in the way in which the knowledge is used. Although students will use existing product ideas as starting points for their designing, it is important that they introduce some elements of novelty. A highly derivative 'copy', however well made, does not constitute good designing or reveal design and technology capability. Even a tiny amount of creativity will involve students in taking risks (i.e. deciding to do something that they have not done before and that they are not certain will work). Too much risk and the result may be failure and disappointment. Not enough risk and the result will be bland and uninspiring. The role of the teacher will be to help the students manage the risks they are taking. Formative assessment will be crucial here as it provides the gateway for the two-way feedback between teacher and student about the 'riskiness' of the ideas in hand (Barlex, 2003).

It is through the acts of designing and making that students develop, and reveal, their capability. When