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QUALITY LEARNING FOR TECHNOLOGY EDUCATION: AN EFFECTIVE APPROACH TO TARGET ACHIEVEMENT AND DEEPER LEARNING

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Abstract

In recent times the role of the student in the learning process has received an increasing recognition. They have been transformed from passive receivers and regurgitators of knowledge to active participants at all stages of the learning process. The aim of this research is to introduce and review elements of an educational design for successful teaching and learning in Technology Education. The design utilises a sequenced pathway for successful achievement that details the intended learning, develops multifarious teaching episodes, provides opportunities for tangibly-evidenced student work, and identifies the criteria for successful achievement. It utilises an example of a practical activity that encourages informed participatory experiences to demonstrate examples of good practice in teaching Technology Education. Student involvement in the learning process begins with the identification of meaningful purpose and relevance while their practical work encourages cooperation, authenticity and individual accountability through portfolio assessment. The end result of their endeavour is measured in terms of their success in further developing their technological literacy.
Key words: *formative assessment, inquiry learning, planning, quality learning, technology education.*

Introduction

The acceptance of students as partners in the learning cycle, is now widespread and the feature of much research. They are now, more than ever, better informed about their learning, introduced to frameworks and processes to improve their learning, and given greater freedom to choose the avenues that their study may take them. This flexibility and involvement will greatly affect the teacher's work strategy and the nature of their planning and teaching. Greater involvement of students has the advantage of increasing motivation and engagement in teaching episodes and therefore often leads to a more effective classroom learning environment which is a positive for all. Teaching and learning needs to be strongly linked to developing the achievements required in the curriculum and teachers must ensure that classroom activity is based on significant learning and not merely on peripheral or 'busy' work. It is easy for teachers to keep students busy on activities but what is the purpose of this work? Is it to promote learning or just to keep them engaged or entertained?

The teaching and learning opportunities provided by Technology Education programmes through the nature of the contexts used, tend to lean toward more meaningful learning. Such programmes can easily become a vehicle for the integration of most other learning areas. Darling Hammond (2008) states: "… there is a growing body of research indicating that students learn more deeply and perform better on complex tasks if they have an opportunity to engage in more 'authentic' learning" (p. 12). A predominate method of learning in these programmes is an

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inquiry approach where there is significant use of group collaboration and on-going formative assessment that requires application of knowledge and critical reflection on student's practice and reasoning.

Authentic learning, pedagogy, and activities, (Snape and Fox-Turnbull 2011) along with formative assessment are important aspects to consider in best practice teaching and learning. The educational design featured is a teacher planning framework for successful teaching and learning. An authentic and meaningful context will be used to give examples and demonstrate its suitability for use in Technology Education programmes of work.

Research by Clarke, Timperley & Hattie (2003) and Clarke (2005) is a significant part of the success of this teaching and learning framework. It is now firmly established as best practice in a high percentage of New Zealand schools and is prominent in the University of Canterbury's initial teacher education (ITE) programmes. It has led to a quantum classroom culture shift from programmes that were once activity based to ones that encourage students to be actively and intrinsically involved (Clarke 2003) in significant learning. Supporting the use of authentic learning in this process is the inclusion of formative assessment practices (Black & Wiliam 1998), as a way of including students in the learning process. Students are regularly informed about their progress, and extend their learning through critical reflection as they identify future learning needs.

This qualitative research into successful educational designs has strong links to the methodology of design-based implementation research (Penuel, Fishman, Cheng and Sabelli 2011) but at a class rather than organisational or systemic level. They state '... much design-based implementation research asks questions such as "What works when, how, and for whom?" The design in this study has been used in an ITE programme as a suggested format for teaching. ITE students using it while on teaching placements have commented its suitability and the way it clearly focuses their teaching on the curriculum objectives while totally engaging children in the activity. Making explicit links to the learning purpose has focussed the children's attention on what can become transferrable learning in future study.

The potential utility of design research for supporting implementation also derives from its focus on developing practical theory and tools that can be used to support local innovation and to solve problems (Reinking and Bradley, 2008).

What is the theory behind this innovation and how is the framework structured?

Significant Elements of the Teaching and Learning Process

Authentic Learning

Two key aspects that enhance quality learning opportunities are firstly, the use of authentic pedagogies and instruction, and secondly the inclusion and use of authentic activities. Turnbull (2002) describes authenticity in Technology Education as being based on connecting students' understanding to meaningful and real-world situations and their involvement in technological practice that is similar to practicing technologists while using authentic tools and processes.

Splitter (2008) urges caution here, especially in connection with 'real-world' associations. He says that many of these do not necessarily guarantee truly authentic teaching and learning. Much of the 'real-world' can seem phony, second-hand and inauthentic. It is not enough to just focus on 'real' world contexts, attention must be given to what 'ought to be' happening in the particular situation or scenario that is being used and the roles of those involved. Newmann & Wehlage (1993) base authentic achievement on students constructing meaning and producing knowledge through disciplined inquiry which generates discourse, products and performances that have meaning beyond just success in school.

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Newmann and Wehlage (1993) identify five standards of authentic instruction to appropriately engage students in their learning. They say higher-order thinking, depth of knowledge, connectedness to the world, substantive conversation and social support for student achievement will encourage students to try harder to master higher learning.

These findings are also supported by Slavkin who states: "knowledge should be socially created" (2004, 7). He identifies that learners function best in environments that are intriguing, multi-sensory and dynamic. The views of Newmann and Wehlage (1993) and Slavkin are supportive of the socio-constructivist theories that feature highly in today's educational environment and are particularly relevant to technological practice.

Authentic Activities

Reeves, Herrington & Oliver (2002) present ten design characteristics of authentic activities that they identified in literature. They suggested these would make a suitable checklist for educators keen to promote authentic learning.

Authentic activities:

(1) have real-world relevance
(2) are ill-defined requiring students to define them in order to complete the activity
(3) comprise complex tasks to be investigated by students over a sustained period of time
(4) provide the opportunity for students to examine the task from different perspectives, using a variety of resources
(5) provide the opportunity to collaborate
(6) provide the opportunity to reflect
(7) can be integrated and applied across different subject areas and lead beyond domain-specific outcomes
(8) are seamlessly integrated with assessment
(9) create polished products valuable in their own right rather than as preparation for something else
(10) allow competing solutions and diversity of outcome (Reeves et al. 2002)

Real-world relevance as identified in the above list is a critical aspect of the process. Where learning experiences and analogies relate to the world of the student learning connections will be more enhanced. The relevance gives meaning and purpose to their direction and promotes stronger engagement. Teachers of technology will easily connect with this list and identify the way these activities reflect what happens as good practice in their teaching and learning programmes. The use of authentic activities developed using authentic pedagogies is significant in the teaching and learning framework that the writer introduces to initial teacher education students.

A list of characteristics of learning in Technology Education also appeared in the *Technology in the New Zealand Curriculum* (Ministry of Education 1995). These characteristics clearly recognise the significance of authentic pedagogies, teachers and learners, and the activities important to deep and meaningful learning in technology education (Newmann 1996; (Newmann, Marks, & Gamoran 1995; Petraglia 1998; Splitter 2008).

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Black and Wiliam's (1998) review of literature about formative assessment, summarised in *Inside the Black Box* (www.qca.co.uk), highlighted the role of the student in the learning process and encourages a collaborative and coordinator role for the classroom teacher. They raised attention to the importance of on-going assessment, evaluation, and feedback as significant considerations when involving students in the learning process. Clarke (2005) encapsulates formative assessment practice as including: modelling existing work examples, co-constructing success criteria, using talking partners to maximise student engagement and asking worthwhile questions.

The essential consideration with formative assessment is that the assessments must inform learners of their progress and lead to an opportunity for them to use the feedback to improve their performance. Assessment is not a matter of just measuring ability, but identifying what the learner's perspective and ability is compared with the intended learning. Assessment will acknowledge where their work meets requirements and will then give appropriate direction to next learning steps. This can be a time consuming exercise and one that will challenge teachers in institutions where there is a predominantly content-driven and prescriptive curriculum. In classrooms where formative assessment is alive and well there will be greater learner choice and engagement, a significant degree of co-operative and collaborative activity, and deeper learning often achieved through quality discourse between teachers and other learners in the class.

The framework for quality teaching and learning therefore is founded on authentic achievement and formative assessment, and is based on the five critical components shown in Table 1. An explanation of these factors follows with each expanded using an authentic technological learning context to identify their significance.

Table 1. Critical factors in the teaching and learning process.

Learning Intentions	Learning Experiences	Curriculum Component	Technological Learning Evidence	Assessment or Success Criteria

Authentic Technological Practice Example

To help better understand the nature of the components of this sequence a context from a practical activity in an initial teacher education Technology programme is used.

Table 2 below introduces the technology design brief used in this practical activity. The Chocolate Box context asks students to design a gift box of themed and crafted chocolates for parents who have assisted them in a classroom or school activity. Students observe demonstrations of the vacuum-forming and chocolate crafting processes, and then use a design process to brainstorm, generate ideas, select options, sketch, plan and produce their individual and group outcomes.

As a group students choose a theme and then design some potential individual chocolate contributions. They will design and produce a pattern from dough or medium density fibreboard, create a vacuum-formed styrene mould and then set their chocolate using white, dark and milk chocolate for aesthetic enhancement. The group will then design and develop a suitable package to contain, display and present their gift. The activity is extremely engaging and provides an excellent platform to address the learning achievement objectives of the Technology curriculum.

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Table 2. The Chocolate Box design brief.

The Chocolate Box
Conceptual Statement: At times during the school year parents are asked to help out in the classroom programme. To thank them we could offer a small gift. A box of handmade and themed chocolates would be an appropriate measure of thanks. Safely produce and package handmade chocolates for a gift. Process: As a member of a group of five or six, sketch and consider several designs you could use that relate to the selected group theme. Draw one in detail and then use MDF or dough to form a pattern. Using food grade styrene plastic vacuum-form the pattern to make a mould for your chocolate. You can add white chocolate and dark chocolate features to enhance the design. Once your chocolates are made consider, design and construct a package for them. Have them ready to present to parents at our next assembly.

Quality Teaching and Learning Framework

Learning Intentions

Formative assessment has as one of its tenets a student focus on how they learn. The goal of this is to engender an appreciation of lifelong learning and an understanding of how the learning process works. Constructivist classrooms provide students with the support, guidance and involvement to help make this happen and it is the inclusive nature of this learning process that helps establish the valued teacher/student partnership, increasing motivation and engagement.

Teachers will need to consider the appropriate time and way to share these learning intentions. In most cases it will be necessary to provide the context for the learning and some topic immersion to capture, engage and direct student attention. It is also important for learning intentions to be delivered in ways that students can easily understand. Displaying them visually, as well as giving them aurally will help cater for some different learning styles and also get students to review them independently.

A learning intention will focus on the relevant skills, knowledge, understanding and applications that the teacher has identified as critical in the learning process. It is this clearly defined focus established early in the process that provides the foundation for teaching activities. Teachers can now plan learning experiences utilising effective pedagogies (Ministry of Education 2007) that will best achieve what has been determined. Students can take greater responsibility for their learning when they are clearly informed of where to focus their attention. As learning progresses these well-defined learning intentions can be used by students to complete self-evaluations and as teacher or peer evaluation. This creates a significant opportunity to revisit the key learning and view it from a different perspective and purpose, thus enhancing learning development.

It is essential that well-formed skills and concept-learning learning intentions separate curriculum learning from the activity or context being used to support and develop that understanding (Clarke et al. 2003). Muddling the context and focussed learning can lead to compromising the desired intent and have the learner believing that the activity is still the significant factor. In a technology education learning context students may:

- *describe the attributes of the intended outcome*
- *identify and record the key stages and resources to develop an outcome*
- *use a flow chart to develop a sequence for the intended practice*

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Learning Experiences

Experiences used to promote successful learning must be carefully planned to maximise the opportunity. They need to be motivating, meaningful and designed to fully engage students in discourse that promotes deeper learning. Education Queensland, cited by Moulds, (2004) have defined these as 'rich tasks' using terms such as: substantive and real problems that model life roles, engage students in social action with real world value, require analysis and theorising, and engage students intellectually in transdisciplinary activity.

Moulds (2004) identifies that rich tasks: "focus on learning a discipline, have abundant connections to a real-world context and have accessibility to students" (p. 76). 'Accessibility to students' relates to the ability of tasks to actively engage students in their work. While Moulds' article on rich tasks is describing a more macro task consideration, learning experiences in technology programmes demand this process at a micro or lesson level. Experiences need to link strongly to authentic pedagogies and practices, promote learning of technological content knowledge, and deeply engage students particularly in collaborative and cooperative ways where substantive discourse will be a key element.

It is strongly recommended that each unit of work provides a number of 'coat hanger' experiences. These are significant or memorable events that students can connect to, or 'hang', their learning on, e.g., a first-hand visit or a visitor to the class. Recalling these events will prompt students to recall other related learning and activities. It is essential that learning experiences are designed to develop the intended learning and that they are appropriate to the level of understanding, interest, and challenge of the students. They will promote successful curriculum understanding, inform their technological practice, and develop the procedural, conceptual, societal and technical knowledge (Jones & Moreland 2001) that is the foundation of technology education and technological practice.

A recent addition to technology curriculum support in New Zealand has been the *Strategies for engaging students* resource (Ministry of Education 2009). This offers teachers a multifarious range of strategies that will promote and enhance learning in Technology Education. The resource connects focussed technology learning with appropriate strategies and an explanation as to how they can be used. The strategies are particularly diverse, utilising higher-order, collaborative and meta-cognitive activities, and will often transfer to other learning areas. In a technology education learning context students may:

- *view a video of the process used by a local chocolate maker to apply aesthetic qualities to a hollow chocolate bear and describe this by listing the key stages.*
- *visit a chemist and gift shop to photograph potential gift packaging possibilities.*
- *brainstorm ideas for their chocolate gift packages and present a conceptual drawing of their chosen outcome.*

Curriculum Connections

To help student teachers ensure they have a good coverage of the curriculum strands and achievement objectives, and to encourage a holistic perspective to Technology Education in the primary school a technology curriculum connection column has been included. This will help students relate their planning to the Technological Practice, Nature of Technology and Technological Knowledge strands (Ministry of Education 2007) and to the eight components that define them. Curriculum learning will be significantly enhanced when teachers have a well developed understanding of the contents and can successfully link learning activities to the curriculum achievement objectives.

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Technological Learning Evidence

To enable teachers to provide appropriate and necessary feedback and complete their required assessments, student activity will need to generate evidence of the learning that has been achieved. It is more efficient, timely, and beneficial if the learning experiences develop the evidence that teachers and learners will need to both confirm learning and identify misconceptions that may present. Feedback from the teacher or peers on this evidence will help the students to ensure they are progressing positively.

To enable this, tangible evidence of learning is obtained from student engagement. This proof of learning will need to be clearly seen or heard in some way to verify individual student learning. Examples of such activity might be: brainstorms, sketches, lists, conceptual drawings, posters, explanations, portfolios, technological outcomes, self or peer evaluations, role plays, demonstrations etc. It is this evidence, being the result of student engagement, which will give the teacher what is needed to assess learning progress and achievement. Even in cooperative activity, evidence of individual performance and reflection can be determined. In a technology education learning context students may produce:

- *a brainstorm of potential packaging outcomes*
- *a vacuum-formed styrene mould*
- *a three coloured chocolate*

Success Criteria

Establishing and sharing leaning intentions alone will not necessarily achieve the significant learning we would want to achieve. It is important that students can see what the learning will look like. Learning can be best identified through the collaborative construction of success criteria, by the teacher using exemplars of successful outcomes, and modelling what might be appropriate for students to develop in response to the activity.

Making these success criteria explicit will help students become more aware of the requirements and high expectations of the teacher. Students will be given the opportunity to learn what should or must be included and will then be able to identify what successful achievement is like. Clarke (2005) states: "Once children have access to the success criteria, they will have a framework for a formative dialogue, with either partners or teachers, which will enable them to: ensure an appropriate focus, clarify their understanding, identify success, determine difficulties, discuss strategies, and reflect on overall success." (p. 37).

It is the chosen success criteria that will be the main focus of feedback in this formative process. Teachers will use the most appropriate learning experiences to achieve the desired learning with evidence being generated and demonstrated in the technological learning evidence. Students should ensure that their outcomes incorporate the particular success criteria required and represent the expectations and demands set out for them.

In a technology education learning context' success criteria for listing key stages and resources may require students to explain what they have done, how it helped, what they might do next and what resources will be used.

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Table 3. A section from the Chocolate Box unit of work showing all five columns.

Learning Intentions	Learning Experiences	Curriculum Component	Technological Learning Evidence	Assessment or Success Criteria
Students develop specifications for a final brief	As a group and considering technological practice construct a final brief with a conceptual statement and clear specifications	Technological Practice – brief development	A completed and appropriately formatted final design brief	Conceptual Statement describes: -what is to be done -why it is being done -who is it for Specifications will clearly describe the features of the chocolates and package

Table 3 shows how these five aspects may look as part of a unit of work in technology education. There will always be a one-to-one correspondence in the first four columns. In a unit of work however, formal assessment cannot be completed for all learning experiences. The assessment column identifies the key stages for assessment against curriculum objectives. It should also be noted though that formative assessment for learning will always be an on-going consideration in the teaching and learning process. Its success lies in the clarity and explicitness of the learning for both the teacher and the learner.

Conclusion

This research has identified that successful teaching and learning should utilise authentic learning, pedagogy and activities to motivate and engage participants in the process. As teaching and learning proceeds formative assessment provides the necessary feedback to learners to make the learning explicit and create appropriate pathways for their next steps. The framework provides the necessary scaffolding for students to initially identify the learning in technology and later enable them to acknowledge where successful learning has been achieved. The process will have involved higher-ordered thinking and considerable opportunities for a shared relationship between students and the teacher. The student will have taken considerable ownership of the practice and more significant learning will have eventuated through their increased motivation an engagement. Frequently teachers can become over-concerned with more peripheral activity in the lesson and lose sight of the curriculum objectives that the learning may present. This framework will help teachers and learners keep a clear focus on learning and at the same time provide valuable information about student progress. As we move into the twenty-first century students will need to become more engaged in their learning, with teachers becoming co-learners and mentors in the process. As student engagement increases they will become learners of much more than content knowledge with a skill set appropriate for life-long learning.

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