

Assessment of Technology in Early Childhood and Lower Primary School using Dimensions of Learning

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Abstract

Teaching and Learning in technology for students aged between three and seven should be designed to build a strong base of understanding and internally driven interest and abilities related to our technological world. In this paper three dimensions of learning are explored as a tool to assess aspects of technology education in the upper early childhood and lower primary school sectors.

In the New Zealand primary sector there are times when students might have achieved at one level but are not ready to move to a higher achievement level. When teaching and assessing technology, teachers rely curriculum and supporting documentation to assist with formative assessment.

Technology education in the New Zealand early childhood sector is not as well-structured or defined as in primary, although students are given opportunities to recognise, use, make and evaluate technology across five strands in the Early Childhood Curriculum. Students are assessed in a range of dispositions but are not formally assessed in technology education. However, teachers may look for ways to extend students' understanding of our technological world.

This paper offers a way to broaden and deepen student learning without necessarily moving them to higher curriculum achievement levels by offering a tool to assist teachers giving feedback as a part of the formative assessment process in technology education. It is envisaged that this paper will precede empirical research on ways to broaden and deepen young students' understanding in technological literacy in both sectors.

Key Words: Technology education, assessment, primary and early childhood, dimensions of learning.

Introduction

When assessing technology is not unusual for teachers to consider that their students are not ready to move to the next achievement level for a variety of reasons even though they have met their current expected level of understanding. Teachers therefore can explore ways to broaden and deepen their students' knowledge and understanding across a range of technology areas or contexts. The framework presented in this paper specifically illustrates how Claxton and Carr's (2010) dimensions of learning can be used to assist teachers to formatively assess students' learning in a variety of ways and acknowledges that learning for students' futures is complex and multifaceted. Claxton and Carr (2010) suggest progress can be represented as change in three dimensions: robustness, breadth and richness. This paper explores learning in technology and then identifies ways in which these dimensions might be applied to assessment in technology education in both early childhood and primary settings.

Dimensions of Learning

Assessment of students' learning and development in technology involves intelligent observation of the children by teachers with the purpose of improving students' technological literacy (Compton & France, 2007). Claxton and Carr (2010) suggest that a number of learning goals, dispositions, orientations or habits are advocated by educators. They also suggest viewing these goals or dispositions as verbs rather than nouns as is the norm. They see dispositions not as 'things' to be acquired but rather a way of doing that increases in frequency and complexity which can be described with applicable adverbs. The example they cite is 'persistence'.

In our view, persistence is not something that a learner 'acquires'. Instead we see growth as a change in likelihood that they will respond to difficulty in certain ways: by sticking with it; voicing doubt and digging below the surface, for example. These responses are then modified by a range of adverbs: an individual engages in them more or less *frequently, or, appropriately, or skilfully*. (2010, p. 88).

The fact that these tendencies can be seen as changing over time allows us to consider what and how teachers can do to assist their students' progress. Claxton and Carr (2010) offer three adverbial dimensions: robustness, breadth and richness, against which progress can be measured. The first, 'robustness' can be thought of as a tendency to respond to learning in a positive way when conditions for learning are not as supportive as they once were. Robustness is a matter of tolerating and managing the emotions of learning. An example from my own experience is Kaleb at 2 years old unable to work the mouse on the computer to play his favourite matching game. Initially an adult needed to support him. When left alone to attempt to use the mouse he became angry gave up playing the game. I talked to Kaleb about not getting upset at failing and that trying again was a good way to learn new skills. Slowly Kaleb became more skilful at using the mouse and was able to accept that mistakes were made and try again. After while was able to work the mouse independently without adult assistance

The second dimension, 'breadth' is concerned with the understanding that what is learned in one domain can be transferred to other settings, sometimes known as knowledge transfer. For example developing skills in working collaboratively in one area slowly develops into the skill of developing collaborative skills and taking leadership roles is a range of other domains. Again let's look at Kaleb. When he first started kindergarten at three years of age he found working with other children in the sandpit difficult. Over the year he started to take

an interest in what others were doing in the sandpit and then started to play with them working on the same project. The skills he learned in the collaborative work in the sandpit were then applied to building constructions from boxes and completing jigsaw puzzles with his friends inside the classroom. His collaboration was broader. Taking on a leadership role in collaboration solving jigsaw puzzles also added robustness.

“Richness’ is the third dimension and involves the development of flexibility and sophistication. Let’s go back to the disposition of persisting to illustrate this. Initially the skill of persistence may mean not giving up on a task, but later problem solving strategies, obtaining assistance, anger control or mood repair may be inserted and become more subtle over time. Claxton and Carr (2010) cite an example in which Sarah’s learning portfolio illustrates a rich range of support she calls on to assist her in making a bag. She discovered her learning was “stretched over’ peers, teachers, family, materials and resources to sustain her three month sewing project which began with a discussion with a friend whose grandmother had taught him to sew, and culminated with a the setting up of a ‘bag making factory’. “She had become much more skilful at marshalling and building for herself the scaffolding she needed in order to persevere in difficult enterprises” (Claxton.G. & Carr, 2010, p. 91). These dimensions can assist in the assessment of social and cognitive dispositions of young children. The next section identifies key elements in which the dimension can be specifically applied to technology education.

Learning and Assessing Technology

Progress in technology is not linear, nor is it a sum of individual parts, but rather a holistic process which can be difficult to assess (Kimbell, 1997). Achievement in technology includes a students’ conceptual understanding of subject matter and their ability to transfer concepts to future learning and new and unfamiliar situations (Pellegrino, 2002).

National or state curricula such as New Zealand’s national curriculum achievement objectives (Ministry of Education, 2007) and the United Kingdom’s Key Stages (National Curriculum website team) go some way to identifying progression in technology. For teachers to be able to have a clear picture of students’ learning further support documents such as New Zealand’s Indicators of Progression (Ministry of Education, 2009) maybe required. These not only identify and break down learning steps but also supply clear teacher guidance and teaching strategies. Compton and Harwood, (2005) Jones (2009) and Pellegrino (2002) suggest more research is needed around the notion and specifics of progression in technology education in the school sector.

In the New Zealand early childhood sector learning technology is not specifically identified in Te Whāriki (Ministry of Education, 1996) however it offers a holistic approach to education, teaching a range of skills, knowledges and ways of thinking that apply directly to technological thinking and doing (Mawson, 2006). Part D of Te Whāriki (p93-99) identifies the technology foundational knowledge and skills embedded in it pages. These include the capability to solve practical problems from the ‘Well-Being’ strand (p94), using materials for different purposes and recognition that different technologies may be used in a variety of settings and places in the ‘Belonging’ strand (p95), experiencing collaborative and cooperative problem solving and understand how technologies assist people in the ‘Contribution’ strand (p96), using communication technologies in the ‘Communication’ strand (p97) and using a variety of technologies for different purposes in the ‘Exploration strand’ (p98). The ‘Exploration’ stand also contains more specific activities and exploration directly applicable to technology (Mawson, 2003). Several learning examples are directly related to

the use and construction of technology, these include: offering degrees of challenge in construction activities (p87), using technology to explore movement in objects such as wheels and pulleys and creating three dimension constructions (p91). Others are related to technological process such as using trial and error to find solutions, giving reasons for choices (p89), developing spatial understanding by fitting things together and taking things apart (p91) and exploring the nature and properties of materials and substances.

How and why students' progress in their technological thinking in the early childhood sector is less defined and structured. A framework using Claxton and Carr's (2010) dimensions may assist teachers in assessing students' understandings of technology and developing their technological literacy in both the early childhood and primary schooling sectors. Teacher knowledge of formative assessment practices will also assist this process.

Assessing Technology using Dimensions

The dimensions can be used to assist with the assessment of technology education in both primary and early childhood settings. Assessing Technology in primary settings occurs through a range of strategies such as observations, work samples and student portfolios of technology practice. Table 2 illustrates how the dimension of learning can assist teachers using the indicators of progression (Ministry of Education, 2009) to assess their students in technology at Level 1 of NZC (Ministry of Education, 2007).

For example in the achievement objective Brief Development the indicators of progression state that students are required to communicate the outcome they are going to produce and identify some attributes.

- To demonstrate robustness students can work towards identifying some attributes with the assistance of their teacher initially and working towards independently to identify other simple attributes.
- To demonstrate breadth students can work towards identifying attributes independently in a new context. For example they may have been taught about attributes when developing a toy and then transfer this knowledge to a new food product they are developing.
- Richness can be demonstrated through an increase in the sophistication of the range and number of attributes identified. Table 2 briefly outlines the type of thinking / activity in each dimension for each of the achievement objectives at L1 of NZC.

Table 2: Assessing technology at Level 1 of NZC using the dimension of learning

	Achievement Objectives	Indicators of Progression	Robustness Students can ...	Breadth Students can...	Richness Students can...
Technology Practice	Brief Development	<ul style="list-style-type: none"> • communicate the outcome to be produced • identify attributes for an outcome 	work towards identifying some attributes with less assistance and with determination	identify attributes independently in a new context having learned what they are in a previous context	identify a more sophisticated range and number of attributes for their outcome
	Planning for Practice	<ul style="list-style-type: none"> • identify what they will do next • identify the particular materials, components and/or software they 	work towards articulating what they are going to make and some tasks they will need	identify sequenced tasks, that need to be undertaken in a new technology	identify several tasks to be completed and the sequence in which they need to be undertaken

		might use	to undertake and what they are going to be made of	context	Identify resources and materials to be used after undertaking informed research
	Outcome Development & Evaluation	<ul style="list-style-type: none"> describe potential outcomes, through drawing, models and/or verbally identify potential outcomes that are in keeping with the attributes, and select one to produce produce an outcome in keeping with identified attributes 	preserver with their annotated drawing or verbal descriptions so that others are able to recognise the intended technological outcome (TO) which relate to identified attributes	transfer drawing skills form planning one TO to another	increase the sophistication of their drawings to include a range of techniques and skills
Technology Knowledge	Technological Modelling	<ul style="list-style-type: none"> describe what a functional model is identify the purpose of functional modelling describe what a prototype is identify the purpose of prototyping 	understand why they are developing models of their TO and therefore transfer this knowledge to their practice	having found that modelling improved their first TO, instigate the need for modelling when developing subsequent TO	use modelling to improve a wider and more sophisticated range of attributes and use a range of modelling techniques to evaluate varying aspects of their TO
	Technological Products	<ul style="list-style-type: none"> identify materials that technological products are made from identify performance properties of common materials identify how the materials have been manipulated to make the product 	develop an increased understanding that TO are made from different materials and that each material has a range of properties	having learned that a specific TO is made of specific materials identify new materials other TO are made of	recognise a wider range of materials and that the materials TO are made of will impact on the way they work
	Technological Systems	<ul style="list-style-type: none"> identify the components of a technological system and how they are connected identify the input/s and output/s of particular technological systems Identify that a system transforms an input to an output 	work towards understanding that components work together to produce a TO	after learning about one system, recognise another system 's inputs and outputs	recognise smaller and more complicated components of systems
Nature of Technology	Characteristics of Technology	<ul style="list-style-type: none"> identify that technology helps to create the 'made world' identify that technology involves people designing and making technological outcomes for an identified purpose 	develop an understanding that some aspects of their world are made and that people design and make these TO but undertaking a process and making careful decisions	having learned at some things in one context or environment are made, recognise the made TO in another context or environment	understand that things that are made are made for an increasingly sophisticated range of purposes and there is a increasing range of factors that people who make To need to consider
	Characteristics of Technological Outcomes	<ul style="list-style-type: none"> identify technological outcomes in a group of technological and non-technological objects 	develop an understanding of what is made and what is natural and	having learned the characteristics of some made things to be able	identify that some objects might be a mixture of made and 'natural' things

		and systems <ul style="list-style-type: none"> • identify who might use particular technological outcomes • identify the physical attributes of technological outcomes • identify the functional attributes of technological outcomes 	understand that people make TO for a reason	to identify other made things based on the criteria used initially	and that some made things come from natural things and understand that a range of people might use one TO for different purposes
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In early childhood settings assessment occurs minute by minute as teachers and peers listen, watch, and interact with students or groups of students. These continuous observations provide the basis of information for more in-depth assessment and evaluation that is integral to making decisions on how best to meet students' needs. Assessment of the early childhood environment should always focus on individual children over a period of time and avoid making comparisons between children (Ministry of Education, 1996). As in the primary sector Claxton and Carr's (2010) dimensions can be used to assist teachers to assess students in and about technology and give them feedback on how to progress within each of the five strands of Te Whāriki (Ministry of Education, 1996). For example within the Well-Being strand the ability to solving practical problems can be illustrated using Robustness, Breadth and Richness.

- To demonstrate robustness students can be assisted in practical problem solving by assist students to decrease the levels of frustration and anger when initial attempts at solving the construction problem of stability when a built tower fail. Students can realising that repeat attempts may eventually lead to an understanding that a wider base assists tower stability or understanding that some ideas will not work i.e. that tall towers cannot have a narrow base.
- Breadth can be demonstrated through the transfer of problem solving skills in one context to another, such as using the knowledge of design stability gained above to assist construction in the sandpit when building a castle or playing leap frog with friends.
- Richness is demonstrated in practice problem solving to an increased sophistication in the understanding of ideas such as learning that reinforcement and structural shape along with base size also assist with stability.

In Table 3 Technology in early childhood education is further explored through illustration across the five strands of Te Whāriki.

Table 3: Progress in aspects of technology in Early Childhood demonstrated using the dimension of learning

Strands	Identified Aspects of Technology	Robustness <i>The children can...</i>	Breadth <i>The children can...</i>	Richness <i>The children can...</i>
Well-Being	<ul style="list-style-type: none"> • solve practical problems 	repeatedly attempt to construct a tower leading to the understanding that some ideas will work and others will not work.	the transfer of problem solving skills in one context to another such as building block towers to building castles in the sandpit	demonstrate increased sophistication about problem solving such as learning that ideas to assist problem solving are multifaceted, e.g.

				structural and materials shape assist stability
Belonging	<ul style="list-style-type: none"> • using materials for different purposes and recognition that different technologies may be used in a variety of settings and places 	understand that the first materials the use may not be suitable and exploration of a range of materials may be necessary	transferring understandings that materials have different forms and functions from one project to another for example using material suitable in one context may not be appropriate in another context	understanding that the same materials may be useful in a range of functions which may change according to the setting in which it is used for example fabric can be used to construct a garment and filter water
Contribution	<ul style="list-style-type: none"> • collaborative and cooperative problem solving • understand how technologies assist people 	Demonstrate that working with others involves giving and taking understand that things help people do things they cannot do themselves. E.g. scissors can assist in separating paper	use cooperative skills learned in one contest can be transferred to other context identify that some tools have multipurpose. If scissors cut paper then they may also cut fabric (or themselves ☺)	demonstrate a range of for collaborating with peers e.g. compromise, walking away, or welcoming others using a range of technologies and beginning to look for tools that may do a specific job
Communication	<ul style="list-style-type: none"> • using communication technologies 	understand that learning to use technologies takes practice and time to perfect	understand that technologies can be used in a range of settings and that techniques used in one technology may transfer to another e.g. swiping a cell phone and a tablet	understand and demonstrate increasingly complex functions of communication technologies.
Exploration	<ul style="list-style-type: none"> • technologies for different purposes • the use and construction of technology creating three dimension constructions fitting things together and taking things apart and explore the nature and 	demonstrate determination and persistence when learning to use a new tool. use a range of materials and techniques to create 3 D constructions	discover that technologies can be used in a range of settings and that techniques used in one technology may transfer to another e.g. swiping a cell phone and a tablet use techniques used in one setting to assist with construction in another setting.	Through exploration, understand that technologies have multiple purposes and be able to use increasingly more complex technologies develop increasing complex constructions with increasing sophisticated joining techniques

	properties of materials and substances.			
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Conclusion

Assessment is an aspect of technology that has been researched from many perspectives (Barlex, 2006; Compton, Harwood, & Northover, 2000; Crooks & Flockton, 2001; Fler & Quinones, 2009; Fox-Turnbull, 2003; Hoepfl & Lindstrom, 2007; Jones, 2009; Jones & Moreland, 2001; Kimbell, 1997; Moreland & Jones, 2000). This paper suggests the use of Claxton and Carr's (2010) dimensions of learning to assist teachers in the assessment of technology in both the early primary and early childhood settings. Assessment of students' learning and development in technology involves intelligent observation of students by teachers and other experts with the purpose of improving students' technological literacy (Compton & France, 2007). It can be seen in the tables above that the dimensions of robustness, breadth and richness can be applied to aspects of technology in both sectors. The framework offers guidance for teachers by considering ways to facilitate and assist students' progress within the context of technology education. This paper does not offer alternative components to be assessed but offers a way to deepen and broaden learning for students aged from three to seven years. It specifically illustrates how Claxton and Carr's (2010) dimensions of learning can be used to assist teachers to formatively assess students' learning in technology at L1 NZC (Ministry of Education, 2007) and within the five strands of New Zealand's Early Childhood curriculum, Te Whāriki (Ministry of Education, 1996). It is hoped that this paper will precede empirical research to deepen understandings of the effectiveness of the tool presented here and to gain further insight into a tools to assist teachers to teach and assess technology to ensure solid foundations in technological literacy.

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