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Development of formative assessment tool for a primary, technology classroom

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Abstract

Teachers and students' interactions in the classroom include a large number of questions, some of which are a key part of formative assessment. Questions can lead to an extended dialogue between the teacher and the student, potentially facilitating a better understanding of the students' conceptions and providing teachers with information to guide student learning. Technology Observation and Conversation Framework (TOCF) was identified as a framework of questions specially designed for a technology classroom. In this qualitative, design-based research, the TOCF was modified for alignment with the New Zealand curriculum and provided to two primary teachers teaching ages 9-10. The version of TOCF reported in this article was developed through an iterative process in an authentic environment. The teachers were interviewed periodically, and modifications were made to the format of the framework. The findings in this paper focus on the outputs of the iterative process and the feedback given by the teachers on the TOCF. While teachers in the study found the questions crucial to deepen student thinking in technology, they faced some constraints in using the TOCF in the classroom. The findings suggest that any introduction of a new resource should proceed slowly in the classroom and time needs to be given for increasing familiarity with the new resource. It is also possible that inexperienced teachers could find adoption of questioning practice quite tricky and would need to be supported extensively to change their practice.

Keywords

Technology education, design and technology, higher-order questions, teacher change, questioning, formative assessment.

Introduction

Questions are ubiquitous in our daily interactions as well as in the classroom. There is increasing understanding in literature and classrooms that questions should be the starting point of a dialogue. The purpose of these dialogues in the classroom could be for teaching, learning or assessment, especially formative assessment. Formative assessment carried out in the interaction between teacher and students could assist the teacher in deciding the direction of learning for the students. Formative assessment is linked to substantial learning gains (Black & Wiliam, 1998).

This paper draws from a more extensive qualitative study that looks at the interactions in the technology classroom and their influence on teachers and students' learning in middle primary classrooms in New Zealand. These interactions begin with questions from a planned framework of questions for technology education – Technology Observation and Conversation Framework (TOCF) developed by Fox-Turnbull (2017, 2018, 2019), which is used as a formative assessment

tool in this study. The scope of this paper is limited to describing the iterative process of the development of the TOCF and the feedback from the teachers about the TOCF.

Interactive formative assessment and questions

In this study, formative assessment is defined as "the process used by teachers and students to recognise and respond to students' learning in order to enhance that learning, during the learning" (Cowie & Bell, 1999, p. 101). Interaction is one way for teachers to formatively assess the students in real-time since the teacher can listen for any gaps in student learning and provide immediate feedback (Bell & Cowie, 2001; Clarke, 2008; Ruiz-Primo, 2011). Cowie and Bell (1999) called formative assessment carried out in interactions as interactive formative assessment and explained that this assessment is informal, unplanned, transient, and usually student-referenced and criterion-referenced.

Asking questions is a crucial part of interactive formative assessment (Bell & Cowie, 2001; Kawalkar & Vijapurkar, 2013; Ruiz-Primo, 2011; van Zee, Iwasyk, Kurose, Simpson, & Wild, 2001; Wiliam, 2011). The quality of a teacher's question can influence the quality of student thinking (Fordham, 2006; Smart & Marshall, 2013; Wilen, 1991). Good questions can be used to diagnose students' ideas, extend their thinking and to scaffold their learning (Chin, 2007; Jacques, Cian, Herro, & Quigley, 2019; Roth, 1996). Different questioning approaches can aid the teacher is shifting the responsibility for learning to the student (Jacques et al., 2019). Despite the pervasiveness of questions in a classroom, few research studies deal with a fine-grained analysis on questioning practices (Chin, 2007; Hill, 2016; Roth, 1996) and find teachers who ask good questions in the classroom (Myhill, 2006).

All types of questions have a role to play in the classroom (Alexander, 2004). However, research and classroom experiences have shown that factual/recall questions are typically answered in a few words (English, Hargreaves, & Hislam, 2002). Limited contribution on the part of the students is a problem since it has been shown that focused, sustained discussion amongst students helps with their learning process (Alexander, Hardman, & Hardman, 2017; Howe, Hennessy, Mercer, Vrikki, & Wheatley, 2019; Mercer & Littleton, 2007). This paper focusses on questions that lead to a dialogue between the teacher and student/s and hence, simple factual or recall questions that are typically answered in few words are not the focus of this study.

Questions are cues for beginning a dialogue between the teacher and the student (Lemke, 1990). Hall and Burke (2006) accurately summed up the importance of discussions in stating, "Meanings and interpretations are co-constructed through discussion and activity" (p. 8). Discussion and dialogue have the highest cognitive potential for the student of all types of talk in the classroom (Alexander, 2004). Through open discussion and dialogue, teachers or other students in the class can provide scaffolding for developing ideas that can lead to powerful learning experiences (Alexander et al., 2017; Applebee, Langer, Nystrand, & Gamoran, 2003). In teacher-student dialogue, teachers need to ask authentic questions and ask for further elaboration, clarification and build on the previous contribution to truly benefit student learning (Howe et al., 2019).

It has been suggested that good questions need to be pre-planned to provoke thought and sustain dialogue (Shavelson, 2006; Wiliam, 2011). Good questions need to be carefully thought

out and shared among different teachers (Wiliam, 2011). Without a repertoire of good questions, teachers could settle for asking recall or factual questions (Jacques et al., 2019).

A planned framework of questions

The Technology Observation and Conversation Framework (TOCF) developed by Fox-Turnbull (2017, 2018) is designed for technology classrooms and provides a guide to the teacher for things to notice, conversation cues, and higher-order questions that develop students' learning in technology. It was designed based on research on classroom talk, 21st-century skills and dispositions and technology aims across multiple countries. This version of TOCF was designed for early childhood and early primary students up to the age of six.

TOCF is presented as a table and the complete TOCF are present in the appendix of the published journal articles (Fox-Turnbull, 2017, 2018, 2019). The rows are the **technology aspects** derived from various global technology curriculums and columns are **behaviours in technology.** The **technology aspects** are Understanding of/exploring the technological (made) world, evaluating current technologies, identifying technological problems or needs, designing and making technological outcomes to meet the needs and understanding key concepts of technology and deploying them in practice. The five behaviours were defined based on the work of Claxton, Chambers, Powell, and Lucas (2011) and 21st-century skills and they are resilience, transference, sophistication & flexibility, reflection and socialisation (defined and explained in Table 1).

Table 1The five behaviours and what they include

Term	What it includes
Resilience	Resilience includes capabilities of perseverance, especially after an initial failure, managing distractions from peers, other activities and people around them, and absorption in any given task.
Transference	Transference included making links to technologies experienced or seen, and experiences undertaken previously, such as using existing cultural knowledge and experiences or Funds of Knowledge. It also included imagining how existing knowledge and skills might be transferred to new situations.
Sophistication and Flexibility	Flexibility and sophistication indicated an increased depth of understanding, as well as an openness to new and potentially strange ideas. Embedded in this behaviour were reasoning and distilling information aimed at assisting understanding and questioning of others. Planning ideas, actions, and making the best use of resources also characterised this behaviour.

Reflection	Reflection described the strategic and self-managing aspect of learning including the planning and anticipation of needs and issues, distilling information for potential use, revision of prior learning and identification of learning that can be transferred to a new context, self-generated questioning and monitoring progress through cognisance of what, how and why learning occurs.
Socialisation	Socialisation is important due to the inherently social nature of technology practice and the physical, social and environmental impacts of technology. Whether engaged in the use of, or development of technological outcomes, students interacted in a social manner. Through collaboration with others, students experienced interdependence with a balancing of self-reliance and socialisation.

Note: Terms and explanation from Fox-Turnbull (2018)

The cells of the table have a series of observation markers, higher-order questions and suggested teacher comments on student technology practice. Some examples of questions are:

- If you/they were to redo this or make improvements, what changes should you/ they make? Why? (Strand: Technological practice and Behaviour: Reflection)
- What ideas did you change after talking to X/group? (Strand: Technological practice and Behaviour: Socialisation)
- What have we already learned that will help us with this design? (Strand: Technological knowledge and Behaviour: Transference)

The TOCF aimed to enhance technology teachers' pedagogical content knowledge and content knowledge and inform their "formative understandings of students' learning in technology" (Fox-Turnbull, 2018, p. 4). It aimed to develop these understandings by facilitating quality teacher-student interactions.

Fox-Turnbull (2018) used her TOCF with teachers teaching with 5-8-year-olds across three countries – New Zealand, England and Sweden. In the qualitative study conducted by Fox-Turnbull with six teachers, the participants stated that the framework helped them in developing a deep understanding of technology and technological practices. It helped them to support students to think at a higher level. The participants recommended that the TOCF be offered during the planning stage and commented that while it was time-consuming to become familiar with the TOCF, it could prove to be worth it (Fox-Turnbull, 2017). The teachers also wanted a more easy-to-use format for quick reference in the classroom. Some of the participants commented that some contextualising of the questions could prove beneficial (Fox-Turnbull, 2017).

TOCF was reviewed for the purpose of a formative assessment tool for this research. The findings about its use as a formative assessment tool will be discussed elsewhere. In this study,

the main change needed was to extend the TOCF to a higher age group for carrying out the research in primary classrooms in New Zealand (NZ). In NZ, up to Year 6, generalist classroom teachers typically teach technology (Ministry of Education, 2016) which corresponds to age 10. Hence, it was decided to extend the TOCF up to this age group. It was also decided to contextualise the research to the New Zealand Curriculum (NZC) – the exact changes are described in the next section.

New Zealand and technology curriculum

New Zealand curriculum aims to develop young people to be confident, connected, actively involved and lifelong learners (Ministry of Education, 2007). With a view to fulfil the vision, the NZC stresses key competencies to be incorporated in all lessons in the school day. These key competencies are thinking, using language, symbols and texts, managing self, relating to others, and participating and contributing (Ministry of Education, 2007).

Technology education is a mandatory learning area in the NZC taught to students from Year 1 to Year 10 (age 5-14) and non-mandatory from Year 11-13 (age 15-17). Technology is defined in the New Zealand Curriculum (NZC) as "intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities" (Ministry of Education, 2007, p. 32). New Zealand introduced technology education as a mandatory learning area (Year 1-Year 10) in 1995 and implemented it in schools by 1999. The curriculum has changed twice since 1999 - in 2007 to change the strands and technological areas and again in 2017 to introduce digital technologies and computational thinking. The latest changes in the curriculum came into effect from the beginning of 2020.

Teachers teach technology across multiple technological areas – digital outcomes, material outcomes (textile, resistant materials like wood, metal, etc.), process outcomes (food, biotechnology), and design and visual communication (DVC). Within the technological areas, students design outcomes across a range of authentic contexts and broad issues. These design outcomes could be as diverse as designing a recipe book, making a skateboard, designing props for school plays, designing websites or apps to solve local problems, etc. In addition to providing an experience of authentic technological practice, teachers teach specific skills (like 3D modelling, woodworking, soldering, etc.) that students need to be able to design and make their technological outcome.

In the NZC, technology education is taught through three strands - technological practice, technological knowledge and nature of technology. Students are exposed to authentic technological practice while also being exposed to the implications of technology in society. While not all three strands need to be introduced in every single lesson, it is expected that a unit of technology have elements from every strand (Ministry of Education, 2018). The different strands and its components are shown in Figure 1.

In the NZC, technology is taught through eight levels. The student outcomes at each of this level are documented in the 'Indicators of Progression' (IoP) that can be used to evaluate the students' learning in technology (Ministry of Education, 2018). Teachers teaching technology have to integrate the student outcomes that are described in the IoP and the key competencies, in every technology unit.

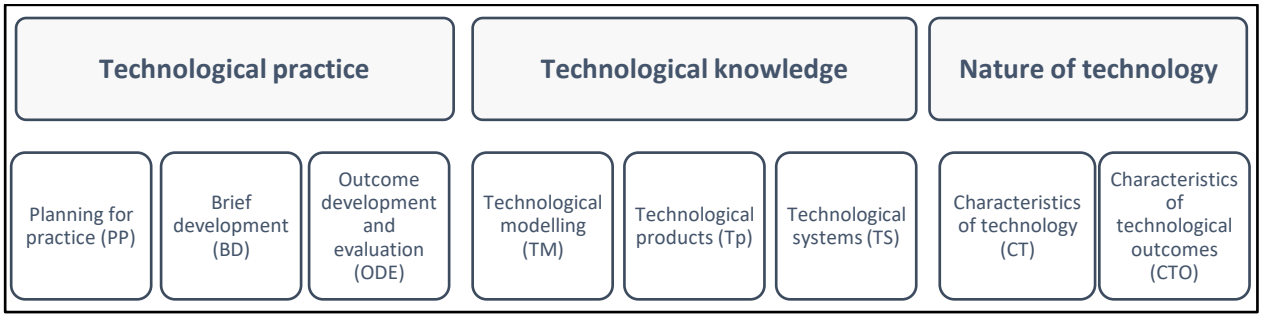


Figure 1: Strands and components of technology education mentioned in the NZC Adapted from Technology in the New Zealand Curriculum (p. 5), by Ministry of Education, 2018.

Methodology

This qualitative study follows the ontological stance of pragmatism, as proposed by John Dewey. The conclusions from a single context in Deweyan pragmatism are not generalizable (Biesta & Burbules, 2003). The methodological framework, known as design-based research (Bakker, 2018), aligns with the pragmatic paradigm and is an appropriate approach since the aim in this research is to design/ develop a tool for use in the classroom in a naturalistic environment.

Design-based research

The term "design experiment" was coined by Ann Brown and Allan Collins in the 1990s (Collins, Joseph, & Bielaczyc, 2004). Design experiment is synonymous with design research or design-based research as it is called in more recent publications (Barab & Squire, 2004). It is a strong belief in design-based research that the context matters in terms of learning and cognition and cannot be considered as a variable or set of variables (Bakker, 2018; Barab & Squire, 2004; Collins et al., 2004; The Design-based research collective, 2003). Due to the importance of the context of research, design-based research is carried out in a naturalistic environment (Bakker, 2018). Design-based research aims to investigate an issue or implement an intervention in a specific context through multiple iterations and collaboration between the practitioner (teacher) and the researcher (The Design-based research collective, 2003).

In this study, as two teachers attempted to use the TOCF in the classroom, the format of the TOCF was changed iteratively to develop the TOCF. These rounds of iterations were first carried out with one teacher considering the participant availability. After multiple iterations, the second teacher used the developed TOCF and gave further comments. These iterations and outputs from the iteration rounds are the main findings reported in this paper.

Background of participants

This study was conducted with two primary teachers teaching Years 5 and 6 (9-10-year-old) in an urban area in New Zealand. The two primary teachers - Jean and Sarah-Jane (both pseudonyms) are from New Zealand. Jean had three years of teaching experience, and Sarah Jane was in the 15th year of teaching at primary school. Jean had 26 students in the class, and Sarah-Jane had 30 students. Over 18 weeks, a total of around 150 hours was observed in Jean's class and around 16 hours in Sarah Jane's class – this depended on the context of the

classrooms, availability of the teachers and the teacher's plan for delivery of the technology lessons.

Jean and Sarah-Jane had limited experience in teaching technology. In the initial interview, both informed that they had limited knowledge of the technology curriculum. However, they seemed well versed in the design process and understood its iterative nature. Both considered the design process as key to student motivation and engagement in the classroom and designed their lessons around the design process.

Methods

Ethics was obtained from the University of Waikato. Consent forms were signed by the Principal, teacher, parents and students and pseudonyms have been used for schools, teachers and students to protect confidentiality.

The teacher interviews and observation notes are the primary evidence source. The teachers were interviewed before the technology unit began and periodically through the unit. All the interviews were transcribed using online software, checked and sent to the teachers for member checking. The first author did the data collection, observed the classroom and took detailed notes. The notes had information on the teacher and student actions in the classroom through the observation period. Both the teachers wore an audio recorder when they delivered the technology lessons, and these audios are used to triangulate the findings.

The modification of the TOCF was discussed amongst all the authors on an ongoing basis. The interview transcripts and classroom observation notes were read multiple times before starting the coding process. Some initial quotes and findings were discussed amongst the authors. The interviews were then coded in NVivo. For this paper, the interviews were coded for specific mention of the TOCF framework and these were further coded as feedback on the framework and constraints on using the TOCF. Classroom observation notes were studied multiple times, and instances of development and use of the framework were identified. In case there were any gaps, the teacher audios were used to triangulate the findings. The findings were discussed amongst the authors, and the coding and findings were rechecked and confirmed from the data once again.

Findings

The findings for this paper are focussed on the development process of the TOCF. There were four rounds of iterations. The numbers of rounds were based on participant availability, and each iteration had a specific output at the end. These rounds are described in detail, below.

Iteration Round 1

This iteration round occurred before any classroom observation and focussed on revising the TOCF for use in this study. The original TOCF had observation cues and comments that the teacher could make in a technology classroom. However, these were not the focus of this study, and hence the first modification was to focus only on the questions.
The context of this study is New Zealand primary classrooms. In the NZC for any learning area, progressions and strands are described and teachers are familiar with the concept of strands and levels for progression. Hence, the TOCF was modified to align with the strands from the

NZC technology curriculum and it was decided to have questions at different levels of progression in alignment to the IoP of technology. The benefit of doing this was to familiarise teachers with the IoP as the NMSSA survey (Ministry of Education, 2016) indicated that only a small minority of primary teachers in New Zealand know the Indicators of Progression (IoP). Considering that the target age group was ten, it was planned to develop the TOCF up to the level appropriate for this age group – Level 3 (Ministry of Education, 2007). An additional level – Level 4 was added so that teachers could see the progression for the next level so that they had the option of preparing students for a higher level.

Aligning the TOCF with the NZC and IoP increased the number of questions. The earlier framework had 91 questions and was created for early childhood and early primary students. The modified TOCF had 252 questions and could now be used for students from ages 5-12 (Year 1 to Year 8). The purpose was to provide for students in a wider age range and align it with progression levels 1-4 from the IoP. As it was recognised that 252 is a large number of questions, it was decided to change the look and the format so that teachers would not be overwhelmed with the number of questions. It was decided to cluster the strands such that the teacher would need to access, review and read a limited amount of questions in each lesson.

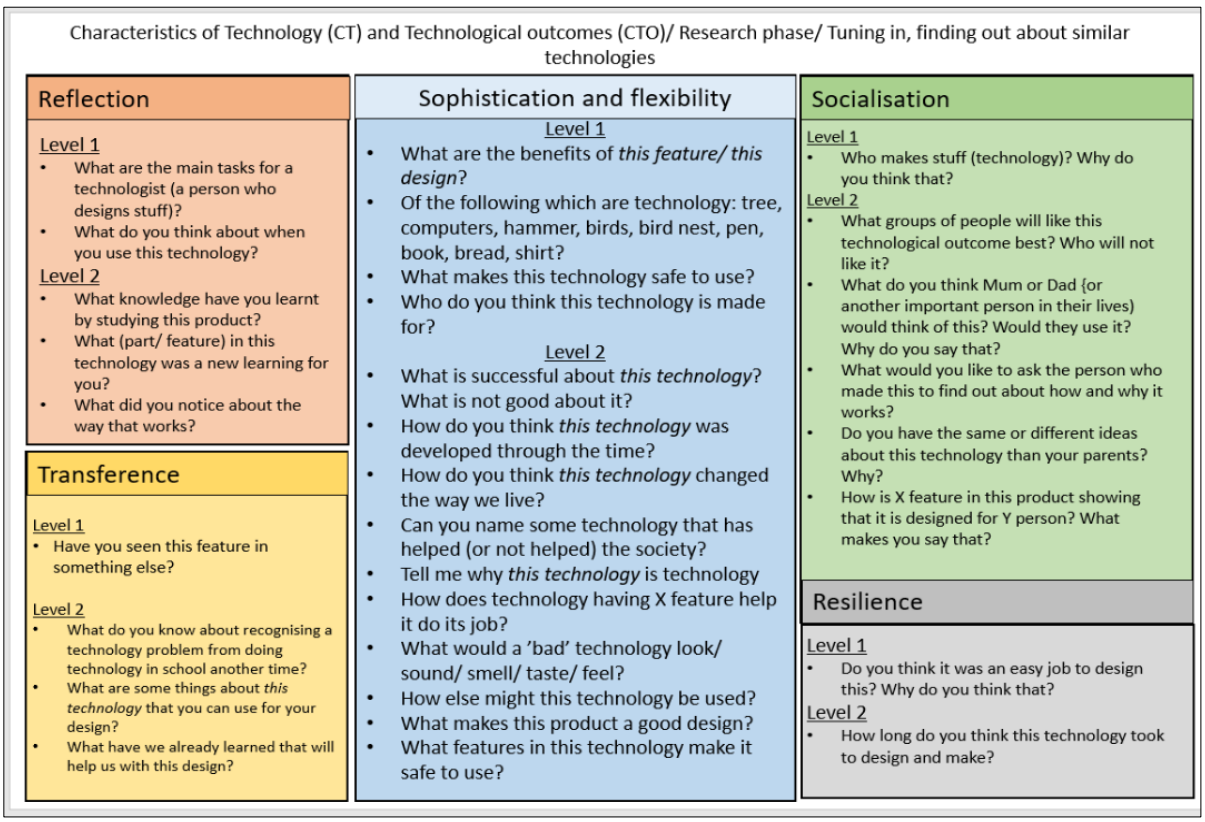


Figure 2: Iteration Round 1 output

Based on authentic technology practice and therefore, chronological use in the classroom, the strands were clustered in the following manner:
The nature of technology: Characteristics of Technology and Characteristics of Technological Outcome (CT and CTO)

- Technological practice: Brief development and Planning for practice (BD and PP)
- Technological practice: Outcome Development and Evaluation (ODE)
- Technological knowledge: Technological Modelling and Technological products (TM and Tp)
- Technological knowledge: Technological Systems (TS)

Each of the above clusters was split into separate sheets. Each sheet had all five behaviours. Every cluster had two pages – one for Levels 1-2 and the other for Levels 3-4.
In any one lesson, teachers may need to refer to up to two pages based on what the students are doing in that lesson. This workaround was conceived with the logic that teachers would look at very few questions in each lesson but still have a bank of questions for their use for multiple age groups or multiple years with the same group of students. Each page could have up to 32 questions. Each of the five behaviours was put in a different colour box so that visually, it was easy for the teacher to refer to a specific behaviour in their questioning. An example of the Nature of technology sheet Level 1-2 can be seen in Figure 2.

However, considering the classroom experiences of the researchers, it was noted that 32 questions could still be overwhelming for a teacher. In the initial interview, the teachers were asked to focus only on couple of behaviours for a unit of technology so that the number of questions that they needed to refer could be reduced to 6-12. The choice for the behaviours would be based on what teachers perceived as important for their students.

Iteration Round 2

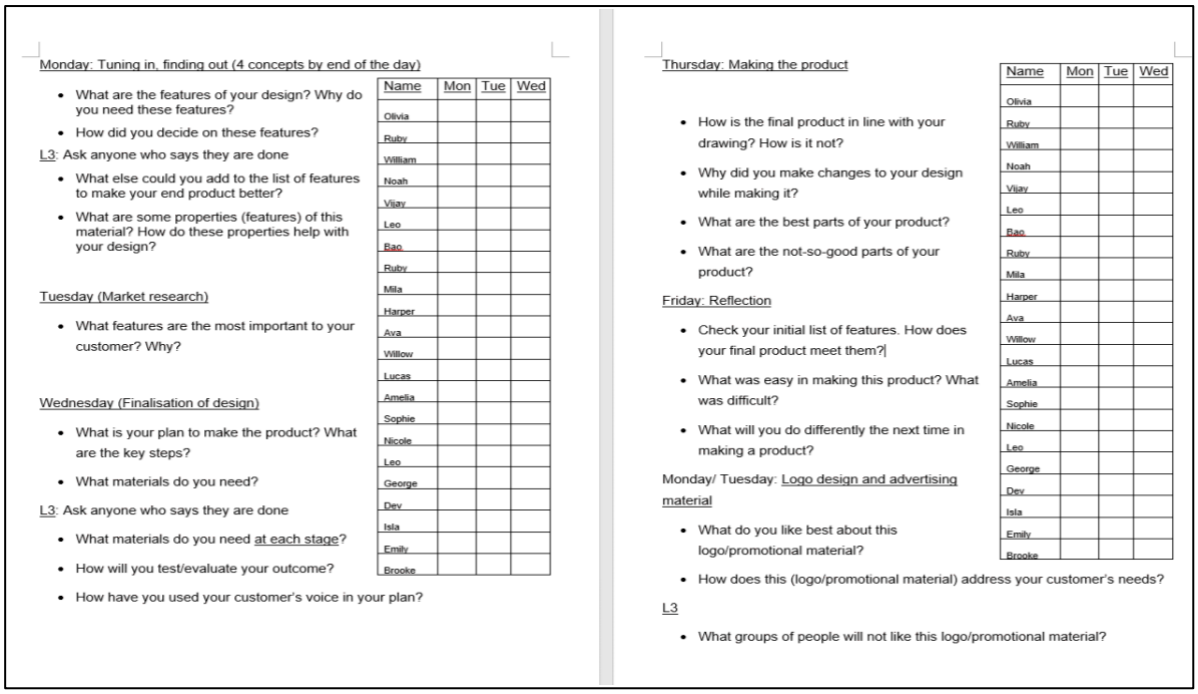
The modified TOCF provided to the teachers was in the form of nine coloured sheets. Both teachers were shown this format and all nine sheets in an initial interview. In the interview and through initial classroom observations, it emerged that the teachers were unfamiliar with the strands of technology. Hence, the titles were changed to reflect more familiar phrases that were in use in the classroom. For example, additional titles for CT and CTO sheet was "Research phase" and "Tuning in" and "Finding out about similar technologies".

Jean used this format in the classroom first. After the first week of observation, it was observed that Jean was unable to use more than 1-2 questions through the week except at the end of the week when she used the TOCF to pick out weekly reflection questions for the students. For the first two weeks, the researcher assisted her in picking these questions for reflection as she found it difficult to find questions from the TOCF.

In consultation with Jean, the researcher decided to temporarily select a few questions and put them on one sheet to support Jean to ask more questions in the classroom. This iteration of the framework was to make Jean comfortable and was not considered as a modification of the main framework. The plan was to go back to the original framework and modify it in such a way that it was easier to find questions. While the researcher worked on a more accessible TOCF version, the modification shown in Figure 3 was a temporary fix.

Jean worked on a different component of technology every day. Accordingly, the questions were picked from different components and were mainly from the behaviour "sophistication and flexibility". As Jean found it difficult to ask all students and keep track of different students'

progress, a student checkbox was added so that Jean could track the students to whom she asked questions. This single sheet of questions was in a physical form that Jean had to carry around in the class.



Monday: Tuning in, finding out (4 concepts by end of the day)

- What are the features of your design? Why do you need these features?
- How did you decide on these features?

L3: Ask anyone who says they are done

- What else could you add to the list of features to make your end product better?
- What are some properties (features) of this material? How do these properties help with your design?

Tuesday (Market research)

- What features are the most important to your customer? Why?

Wednesday (Finalisation of design)

- What is your plan to make the product? What are the key steps?
- What materials do you need?

L3: Ask anyone who says they are done

- What materials do you need at each stage?
- How will you test/evaluate your outcome?
- How have you used your customer's voice in your plan?

Name	Mon	Tue	Wed
Olivia			
Ruby			
William			
Noah			
Vijay			
Leo			
Bao			
Ruby			
Mila			
Harper			
Ava			
Willow			
Lucas			
Amelia			
Sophie			
Nicole			
Leo			
George			
Dev			
Isla			
Emily			
Brooke			

Thursday: Making the product

- How is the final product in line with your drawing? How is it not?
- Why did you make changes to your design while making it?
- What are the best parts of your product?
- What are the not-so-good parts of your product?

Friday: Reflection

- Check your initial list of features. How does your final product meet them?
- What was easy in making this product? What was difficult?
- What will you do differently the next time in making a product?

Monday/ Tuesday: Logo design and advertising material

- What do you like best about this logo/promotional material?
- How does this (logo/promotional material) address your customer's needs?

L3

- What groups of people will not like this logo/promotional material?

Name	Mon	Tue	Wed
Olivia			
Ruby			
William			
Noah			
Vijay			
Leo			
Bao			
Ruby			
Mila			
Harper			
Ava			
Willow			
Lucas			
Amelia			
Sophie			
Nicole			
Leo			
George			
Dev			
Isla			
Emily			
Brooke			

Figure 3: Iteration Round 2 output

Iteration Round 3

Jean used the above modification as much as she used the full version. Only in one instance she sat down with the actual physical sheet and asked four groups of students, questions from the TOCF. She continued to use the TOCF for reflection questions at the end of the week.

In the two weeks that Jean used the temporary modification, the first author in consultation with the other authors changed the format of the framework. As the main trouble was the number of questions in one sheet, the framework was split into multiple small cards, each having 5-7 questions. Only 2-3 "Flexibility and sophistication" cards contained around 7-12 questions. Each behaviour and each strand were separated into a card. The long bulky titles were modified to something short and generic, and the full title was placed at the back of the cards to ensure retention of meaning. All these cards were put in a ring holder so that they could be flipped through easily or removed if the teacher was not interested in individual cards. Example of these cards can be seen in Figure 4.

Jean was offered this format for the final two weeks of observation. While Jean used this format as much as the other formats, she found it easier to look for questions for reflection on her own and did not need the researcher support to look for questions. Her independence with using the TOCF could also be due to growing familiarity with the TOCF.

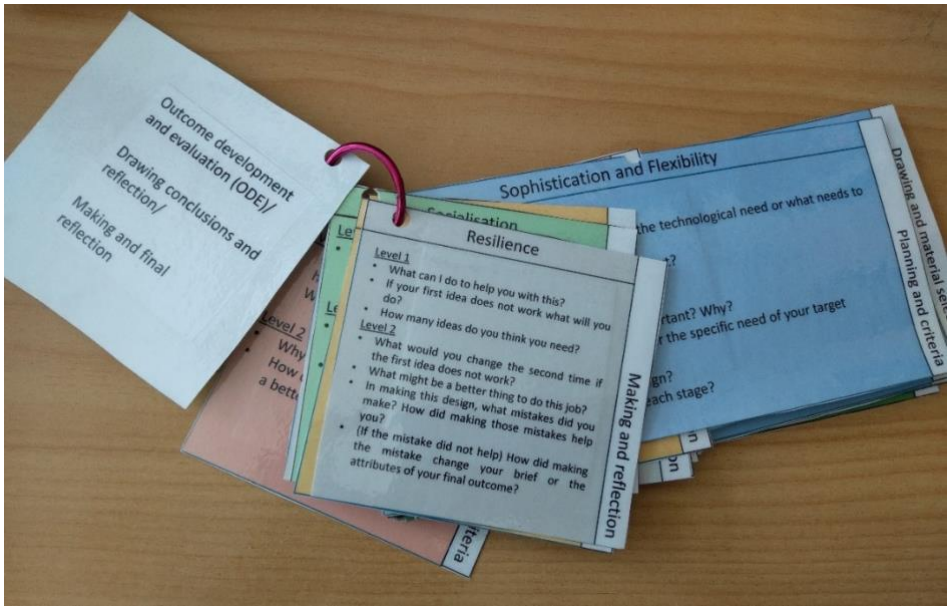


Figure 4: Iteration Round 3 ouput

Iteration Round 4

The output from iteration round 3 was given to the second teacher – Sarah-Jane who commented that there were too many questions, and it was quite complicated. After the observation of the first lesson in the unit, she mentioned again that it was overwhelming to use the TOCF, and in response to this comment, she was offered only four cards. The plan was to add more cards as she got comfortable with using the framework. The four cards were chosen based on what she was planning to focus during the unit and the behaviours she had chosen - Level 1-4 of TM-Tp and ODE on the behaviour "Sophistication and Flexibility". Once she was comfortable using this in the class after four lessons, "Reflection" cards from Level 1-4 for the same components were added. She mentioned in the interview that "I have read them (the cards) more than once now. So that's probably subconsciously here" (T2_I5_Line 81).

After one week of handing over the "Reflection" cards, the data collection ended, and the iteration rounds stopped.

Feedback on the modified TOCF

Through the development process, both teachers gave extensive feedback on the TOCF. The findings in this section refer to the teachers' comments and are organised into two main themes: general feedback on the TOCF and constraints in using the framework. Both teachers had different experiences with the framework, and these will be explained in detail, below.

General feedback of TOCF

Both teachers felt that having the framework in the planning stage was helpful. The usefulness of the framework for teachers in the planning stage was also mentioned by the participants in the previous study (Fox-Turnbull, 2018). Both mentioned that they were unfamiliar with Technological Systems (TS). Sarah-Jane commented that she did not like the Level 3-4 questions of socialisation. She felt that her students would not be able to relate to the questions at that level of socialisation. In contrast, Jean commented that the socialisation questions were “especially good”.

Both the teachers were mainly positive about the questions. Jean commented several times that "I love the questions. Like I really think they are so effective and every time I read them, I thought these are really good" (T1_I7_Line 448). Sarah-Jane commented "You know, if you are not asking those (higher-order) questions, you are not getting them to think better or build on their understanding" (T2_I5_Line70). Jean shared these questions with the other senior primary classes, and during the final interview commented that the questions helped multiple classrooms and all other teachers were impressed with these questions as well.
Sarah-Jane felt that the framework was more of a "teacher-guide" and not for students due to the language. She modified the questions when asking them to the students. One example of modification Sarah-Jane mentioned in the interview was to modify a Level 3 question from "Why did you choose to make X and not Y plan?" to "Why have you chosen this design?" (while pointing to the students' designs).

Both identified that the framework was focussed beyond technical concepts and included attention to the key competencies in the NZC. Jean also mentioned that TOCF inclusion of the behaviours of socialisation and reflection made her feel valued about what she was doing in the classroom. She commented that she knew that her school and she personally valued these behaviours but "seeing it on paper that they are valued by researchers is nice and kind of affirming" (T1_I3_Line33).

Constraints with using the framework in the classroom

Both teachers felt that there were too many questions, and it was overwhelming to read them all together. They also felt that many questions were not age-appropriate. Sarah-Jane was particularly disappointed with the language – she commented multiple times in the initial interview that some of her students would not understand the language of the questions even at the lowest level. Both teachers commented that there were questions in the framework that they could not answer.

While commenting on the use of the framework in the classroom, Jean felt that due to her habits, she would have to change something drastic to be able to use the framework in the class. On the other hand, Sarah-Jane did not express any concerns about using the framework in the classroom since she said she was used to questioning.

Jean did not use the framework in every lesson, even when she was asking questions about students' designs or technological practices. She said that she did not know the questions "off the top of my head" and she found it difficult to carry any paper around. Jean felt that reading the TOCF multiple times was not a good use of her time. While her comments about the TOCF were positive, and she seemed genuinely excited about the questions, she mentioned that her priority was reading, writing and maths. In contrast, Sarah-Jane used the framework in every lesson, as evidenced in the audio recordings and observation notes. Sarah-Jane mentioned that she had read the framework multiple times and that they were in her "subconscious".

Discussion

As the findings section describes, the different iterations were fuelled by teacher feedback on the framework both explicitly and from class observations. Through the design process, the

idea was to make using the framework easier in the classroom for busy teachers who may not have time to go through big sheets with lots of text.

Although it had been explained to both teachers in the initial interview to use only 1-2 sheets in the classroom at a time, the teachers found it overwhelming just to read all the questions and become familiar with them in the initial iteration formats. The earlier motivation for showing the complete framework with 252 questions was to get feedback on them. In retrospect, it can be seen that it may have been beneficial to only introduce a few questions at a time even for feedback. Researchers' priorities differ from the teachers' priorities in the classroom. Researchers need to remember that since they are comfortable with their tools due to the length of our exposure during development, it is not the same for teachers for whom this is not the top priority in the classroom. The design-based research process in this framework development reinforced that it is important to go very slowly with the introduction of new tools in the classroom even if the tools are something the teacher may already be using in their practice.

Jean, an inexperienced teacher, found it difficult to ask questions to everyone in the classroom and also remember the different students' response to guide their actions beyond that moment. She mentioned that her "working memory was full". Jean knew that the answers to the questions could guide her understanding of the student learning process, but to do that for 26 students in the class was overwhelming to her. In response to a different question at the end of a cycle about the design of two girls in the classroom, she did not recall the conversation she had with them which caused them to change their design. She tried to note down comments on a paper and on her computer through the unit, but this was not practically possible every day. These findings support research that shows that inexperienced teachers have lesser recall of classroom memories than experienced teachers (Peterson & Comeaux, 1987) and that they feel overwhelmed (Kim & Klassen, 2018). Novices, in general, exhibit limited processing capacity that constraints learning and performance (Paas & Van Merriënboer, 1994).

In contrast, Sarah-Jane was an experienced teacher. She did not express feeling overwhelmed at asking questions or using student responses to guide her next steps. She felt more in control of using the framework in the classroom and of the cards given to her, she referred to them frequently and asked the questions as is evident from the classroom observations.

Jean's priorities in the classroom also proved to be a constraint in the adoption of the TOCF. As mentioned before, Jean felt her main priority was reading, writing and maths and the technology part was not a priority – creating a barrier to making extra effort to become familiar with the TOCF. As mentioned in the earlier study by the participants, becoming familiar with the TOCF takes extra effort (Fox-Turnbull, 2017). For inexperienced technology teachers, an effort is needed to clarify any confusion they may have face in using the TOCF.
The two teachers were not very familiar with the terminology in the technology curriculum in NZC, as they mentioned in the interview and also evident from the classroom observations. The unfamiliarity with the terminology in the NZC could have led to the resistance that Jean showed to use the TOCF more frequently in the classroom or the resistance that Sarah-Jane initially showed towards the TOCF. Both teachers could then benefit from either a formal professional development in technology or a resource guide for the TOCF that could be developed to explain unfamiliar terminology. Developing a resource guide could also help teachers like Jean, who

may not have access to a researcher/ technology educator in the classroom for the initial support they need to start using the resource.

From the past study done on the TOCF and the experiences from this study, certain recommendations can be suggested about using the TOCF for teachers/teacher educators wanting to try out this resource.

1. Start with choosing only a few cards at a time. Choose one specific behaviour and 1-2 components.
2. Have these cards while starting to plan a technology unit.
3. Modify the language as you see fit for your students.
4. Read the cards multiple times until familiar.
5. Add more cards slowly and only when comfortable with the previous cards.

For teacher educators, an added recommendation could be to provide initial support for teachers not experienced in technology or inexperienced teachers who struggle to ask questions in classroom. Though the TOCF may seem like cards full of questions, due to the alignment with the technology curriculum, there may be unfamiliar terms for an inexperienced technology teacher.

Due to the paradigm of this research, it is not expected that the findings of this research are generalizable. However, the experiences stated here can be investigated in other technology classrooms and with other teachers to check if the conclusions hold true in those cases as well. This research can be extended in the future in other primary classrooms by studying which specific questions are challenging to adopt in the classroom and which are relatively straightforward.

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