Primary Teachers' Perceptions of Their Students' Digital Technologies Competencies

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Abstract: Digital technology has been firmly engrained within the Australian Curriculum for some years now. The recent review of the curriculum has given even greater emphasis to digital technologies as an integral component for teaching content, developing 21st Century skills and citizenship across all curriculum areas. Hence, the question of whether students' digital competencies are at a level that can embrace such integration, particularly from the point-of-view of their teachers is now pertinent. This study looks at how experience and confidence in Primary teachers' competency with digital technologies relate to their expectations of student digital technologies capability development whilst bringing into question the ability for teachers to further plan and integrate digital technologies across all learning areas as per the curriculum intent.

Key Words: primary teacher, primary students, digital technologies, curriculum, student competence, teacher confidence, ICT

Introduction

To keep pace with the importance and rapid change of technologies, Australian Governments have recognized the importance of digital technologies in education. At the turn of the century, a "school education action plan" (Education Network Australia, 2000) enunciated two relevant goals:

1. All students will leave school as 'confident, creative and productive users of new technologies, including information and communication technologies, and understand the impact of those technologies on society'.
2. All schools will seek to integrate information and communication technologies into their operations to improve student learning, offer flexible learning opportunities and improve the efficiency of their business practices.

Such statements have been updated several times, and the most recent national statement of educational goals (Australian Education Council, 2019) includes a variation of the first goal, aspiring to develop "successful lifelong learners who … are productive and informed users of technology as a vehicle for information gathering and sharing, and can adapt to emerging technologies into the future" (p. 7). It also implies the role of digital technologies in enhancing learning when it notes that "in an information and technology-rich society we must ensure that educators are supported to continually develop their own skills, in order to teach young Australians, the essential skills and core knowledge needed for a modern society and economy" (p. 11).

Background

The Australian Curriculum and digital technologies

The most significant curriculum component addressing digital technologies was within the Australian Curriculum: Digital Technologies (ACARA, 2015a). The Digital Technologies subject (ACARA, 2015b) represented a substantial response to successive government-backed statements of educational goals related to information technologies (Australian Education Council, 2019; Education Network Australia, 2000; MCEETYA, 1989). It specified two strands, Knowledge and understanding and Processes and production skills, focusing on learners creating digital solutions through computational thinking, design thinking, and systems thinking. Each strand is specified through a series of content descriptions within the stages, Years F (Foundation)-2, Years 3-4, Years 5-6, Years 7-8, and Years 9-10. In turn, each content description is accompanied by a collection of elaborations that are not prescriptive but offer teachers examples of how the content description might be interpreted for learning activities in a classroom (ACARA, nd-a). The foundations of the Digital Technologies curriculum are based on a sequential development of knowledge and skills from the Foundation Year to Year 10.

To assist teachers in developing their understanding of the Digital Technologies curriculum, ACARA has provided a range of Work Samples on the Australian Curriculum website (ACARA, nd-b). These Work Samples include a range of projects that embed a wide variety of digital technologies tasks. For example, the Foundation to Year 2 level includes the following projects:

- The beach (data collection and presentation)
- Organizing ideas (digital mind map to display data)
- Bee-Bot activity (sequencing and steps using Bee-Bots)
- Systems (Prepare a presentation)

From the ACARA Work Samples, and for each band (Years: F-2, 3-4 and 5-6), there are a range of samples that can be used by teachers to better understand how they can implement the Digital Technologies curriculum. Each year level has a range of Work Samples that match the developing skills of the students and the content descriptors of the curriculum.

Policy for digital technologies in schooling

Perceived relevance to future employment has been a key driver of interest in teaching computer science concepts and skills such as coding in Australian F-10 classrooms (MCEETYA, 2008). Although the idea of teaching coding to all children had been percolating among interested educators for decades, it was not until it emerged as a topic of national parliamentary debate in 2015 that it received broader public attention (Albion, 2016). The rapidity with which digital technologies are evolving has caused some to question whether coding skills learned in primary school will retain relevance over time and, despite a burst of vocal support from politicians and some business leaders, the uptake by schools is not universal. Hunt and Thrupp (2018) studied school websites and found sparse mention of coding, suggesting that there might not be a strong alignment between school implementation of digital technologies and curriculum documents or other government pronouncements.

International interest in, and discussion about, the inclusion of coding and other aspects of computer science in school curricula has resulted in changes to curricula, but there is limited empirical research on the outcomes (Duggan, 2019). Recent parliamentary debates in Australia had highlighted three topics: the infiltration of networked digital technologies into daily life and work, the role of education in responding, and the associated resourcing implications (Duggan, 2019). He voiced concerns about how the focus on technical aspects might distract from educational considerations and concluded that effective implementation required careful consideration of the influence of vested interests such as producers of hardware, software, and educational resources. A study of international education policy related to digital technologies highlighted developments in England, Sweden, and Australia, revealing that policies were being developed in response to various influences, including major global ICT industry players (Williamson et al., 2019). That study concluded that caution would be needed to ensure broad engagement of relevant stakeholders without becoming captive to commercial interests to the detriment of other stakeholders.

Teaching digital technologies in schools

Inclusion of digital technology skills such as computational thinking, programming, and coding in the school curriculum for all students has been hailed by some as an exciting new response to the need for future citizens to have digital technologies capabilities (MCEETYA, 2008) The challenge is that many teachers lack the knowledge of the content and how to teach it (Redmond, Albion, Smart, Powell, 2021). To overcome this, computing in schools shifted to developing skills with office productivity software or supporting learning with simple instructional software. Implementation of the digital technologies curriculum faces a similar challenge in that most teachers have little or no knowledge of digital technologies beyond the use of standard software (Albion, 2016). Therefore, for successful implementation of the digital technologies curriculum, the current state of teacher knowledge must be well understood, and appropriate professional development provided. Many teachers may not have been exposed to, or have studied the successful teaching of digital technologies, so as to be confident to teach it. In such cases, appropriate professional development in content and method will be critical for success. The International Federation of Information Processing (IFIP) researchers recognized that as a challenge to the efficacy of the digital technologies curricula (Webb et al., 2016). To assist teachers in developing their knowledge, multiple efforts have included a massive open online course (MOOC) available to teachers in all Australian schools (Falkner et al., 2015), regional face-to-face workshops (Bower et al., 2017), local initiatives by individual schools (Stone, 2020), and a national program of additional support for disadvantaged schools (ACARA, 2020).

Concurrent research has reported mixed results for the preparedness of Australian teachers for the digital technologies curriculum. Researchers associated with the MOOC reported that survey data from 119 teachers indicated reasonable levels of confidence related to digital technologies topics but a need for more time and support to develop appropriate assessments (Vivian & Falkner, 2018). A study of forum posts related to the MOOC found that primary school teachers had developed a range of ‘unplugged’ activities that supported learning of digital technologies concepts without direct access to computers (Vivian & Falkner, 2019). They also noted that examining the types of knowledge demonstrated in teacher contributions helped inform the development of support materials for teachers. A series of computational thinking workshops developed by Bower et al. (2017) addressed topics including how to embed computational thinking in the curriculum, whether teachers feel prepared to teach it, and what additional professional development might be needed. The workshops rapidly increased teachers’ capability and confidence for teaching the digital technologies curriculum. Relevant and ongoing professional learning is essential for teachers implementing the digital technologies curriculum. This paper seeks to contribute to that body of information by addressing the question: How ready do primary teachers think their students are to complete digital technologies tasks in line with the sequence of development as suggested in the Australian Curriculum?

Method

This quantitative study utilized a survey to collect data from teachers. To understand teachers’ confidence and their understanding of their student’s competence, the Digital Technologies Work Samples for each band (Years: F-2, 3-4 and 5-6) were analyzed against the requirements of the Australian Curriculum - Digital Technologies. These Work Samples were reviewed in detail to understand the requirements of the tasks to then determine the expectations of the tasks for teachers and students. This analysis was used to develop the question sets used in this research project. Unlike other research projects where a range of tasks can be determined by either teachers or academics, this project used the tasks determined by the curriculum authority. These tasks were collected by ACARA to represent the Australian Curriculum expectations.

Research ethics clearance was obtained from the university before the survey was distributed to the research team's personal and professional contacts and a snowballing technique or chain-referral-sampling (Etikan, Alkassim, & Abubakar, 2015). By providing the URL for the survey in social media posts, teachers across Australia were invited to complete and share the survey request within their professional networks. The snowball sample is considered effective in accessing participants who are hidden or difficult to reach (Atkinson & Flint, 2001).

The survey began with some simple demographic questions, including whether the respondent was a current teacher or pre-service teacher, gender, location (in broad terms), current employment as a teacher, years of general teaching experience and digital technologies teaching experience, and year level currently being taught. To minimize the time required to respond, questions about learning activity and specific content of the digital technologies subject were limited according to the year level indicated for recent experience.

All respondents were asked about their familiarity with the digital technologies curriculum and what relevant professional learning they had accessed. The remaining items were tailored to relevant stages (Years F-2, 3-4, or 5-6). For each level, respondents were presented with brief descriptions of learning activities appropriate to the stage and a collection of two to nine subtasks that could be encountered in completing the activity. They were asked to rate their confidence to complete the subtasks using a 5-point scale ranging from 'no confidence' (1) to 'extremely confident (5). In addition, they were asked to rate their expectations of how many students in a typical class would be competent at each subtask by the end of the relevant stage using a 5-point scale from 'none' (1) to 'all' (5). They were finally presented with an open response item inviting them to provide examples of how they could teach or assess the relevant content descriptions.

Findings and Discussion

Surveys sufficiently completed for analysis were returned by 83 current teachers – 12 males and 71 females. Most (58%) selected 'metropolitan' as their location with the remainder selecting 'regional' (27%), or 'rural' (15%). All states and territories were represented in the responses, but the majority (N=66, 80%) were from Queensland.

The data highlighted that 65% of teachers had over ten years of teaching experience where 34% had over twenty years of teaching experience, while 19% were in their first five years of teaching. Only 10% were not experienced in teaching with digital technologies, with almost a quarter having a role as a lead or mentor teacher in digital technologies. In terms of novice, at least one teacher in each level of teaching experience admitted to being a novice with digital technologies, and the greatest number of self-designated novices (3) in a single band had more than twenty years of teaching experience. From another perspective, the data highlighted four teachers with three to five years' experience who claimed some role as a lead or mentor teacher with digital technologies.

In response to items seeking agreement with statements beginning "I am confident using digital technologies for", respondents generally expressed confidence in using digital technologies for teaching and learning, personal purposes, and administrative purposes. As shown in Figure 1, expressions of neutrality or disagreement with a statement about being confident attracted fewer than 20% of responses for any purpose. In addition, 73% strongly agreed that "it is important to use digital technologies for teaching and learning", and a further 20% agreed mildly with that statement. Thus, it is possible to conclude that these teachers were 'confident' (rating 3 on the Likert scale) in the use of digital technologies and positively inclined toward the use of digital technologies for teaching and learning.

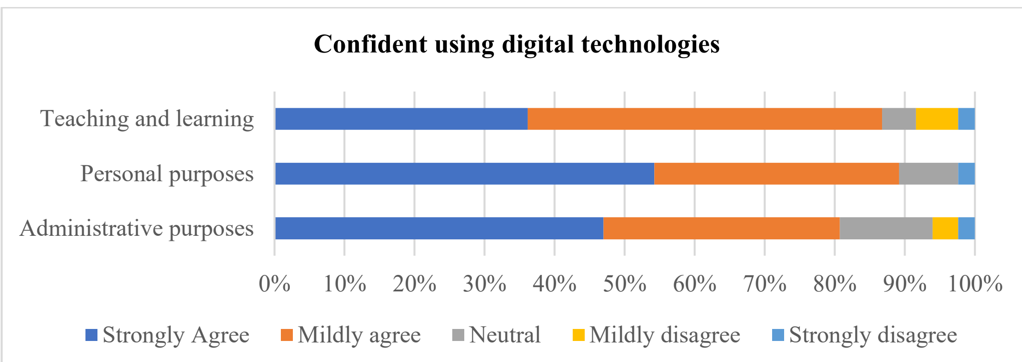

Figure 1. Teachers' confidence using digital technologies

Most respondents reported that students in their classrooms had reasonably frequent opportunities to complete the digital technologies activities while more than half (N=45, 54%) reported that students had these opportunities on average at least once a week. Other arrangements identified included more concentrated blocks of access each term or year. In response to a question about familiarity with the digital technologies curriculum, a substantial minority claimed to be 'very familiar' (27%) and almost half (42%) claimed to be 'somewhat familiar', while, of the remainder, 23% selected 'aware', leaving just 8% who selected 'not aware'.

Table 1 summarizes the results for teachers' confidence and their expectations of student competence for the sample digital technologies learning activities grouped by stage. The numbers of responses (N) at each stage and numbers of sub-tasks in each activity are shown in parentheses. Teachers' confidence ratings were mainly above the midpoint (3 = 'confident'), indicating substantial confidence that they could complete the activities themselves. The sole exception to that was the 'simple robot programming' in Years 3-4, for which the mean rating was 2.9, which is not appreciably below the mid-point confidence level. The implication is that most of the teachers had sufficient confidence in their capability with digital technologies to support the implementation of activities that would enable students in their classrooms to develop the relevant competencies.

Activities identified in the Australian Curriculum	Teachers' own confidence in completing activity	Teachers' thoughts on student competence in completing the activity
Years F-2 (N = 27)		
Collect and describe an object of interest (10)	4.2	2.7
Organizing ideas (9)	3.5	2.0
Simple robot programming (5)	3.7	3.2
Software and hardware systems (2)	4.3	3.3
Years 3-4 (N = 24)		
Digital systems (7)	3.2	2.8
Organizing ideas (9)	3.6	2.6
Simple robot programming (7)	2.9	2.5
Years 5-6 (N = 21)		
Gaming learning tool (9)	3.5	2.8
School networks (4)	3.4	3.0
Binary numbers (2)	3.4	2.7

Table 1. Mean ratings for teacher confidence and expected student competence on learning activities

However, teachers did not have high expectations for developing student competence, with all but three results less than the midpoint of the scale (3 = 'about half'), indicating that they expected fewer than half of their students to develop competence with an activity. No clear patterns emerged from the averaged data, but some apparent anomalies suggested a more detailed exploration of data from specific activities. The lowest average rating for student competence (2.0) was recorded for the 'Organizing ideas' activity in the Years F-2 stage. It shared the largest gap between teacher confidence and student competence (1.5) with the first Years F-2 activity.

Figure 2 presents the distributions of responses on the sub-tasks of the 'Organizing ideas' activity. About 70% of the teachers expected that most or all students would achieve competence at the first sub-task, which was taking photographs with a digital camera or tablet, but no more than about 30% expected half or more of their students to develop competence with the other nine sub-tasks. On the final four sub-tasks, 50% or more of the teachers expected that none of their students would develop competence. That pattern closely matches the pattern in teacher confidence for the same sub-tasks (Redmond, et al., 2021), suggesting that teachers reasonably expect students to struggle with tasks that the teachers find unfamiliar or difficult.

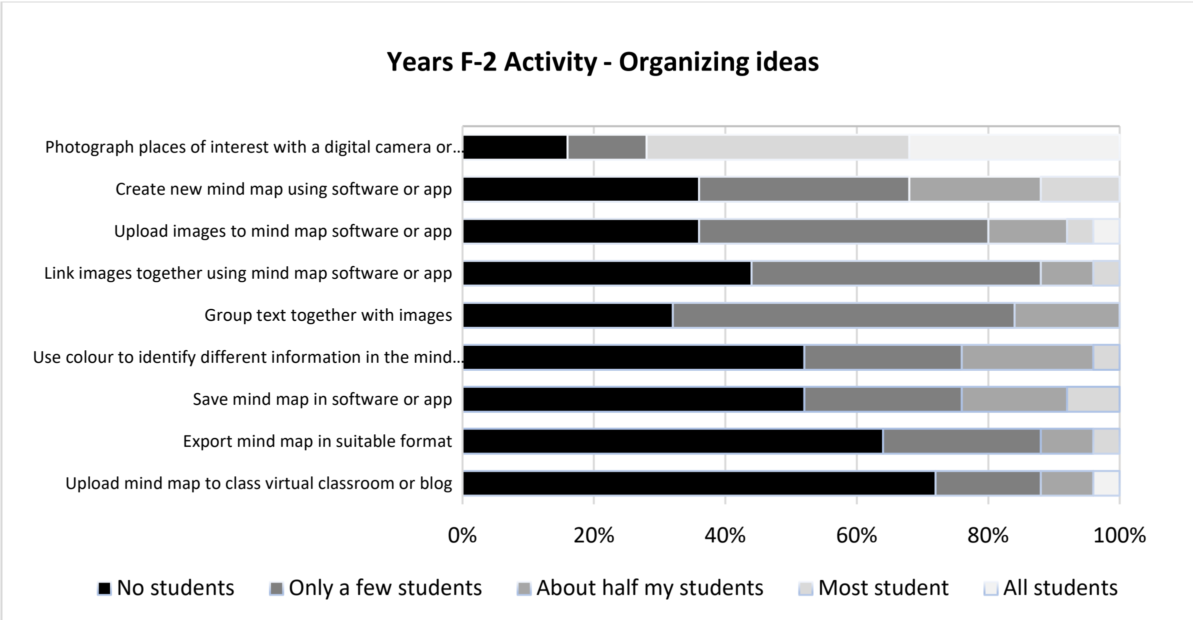

Figure 2. Anticipated student competence on sub-tasks of Years F-2 Organizing ideas

A similar, if not so pronounced, pattern appears for the equivalent activity in the Year 3-4 stage, as shown in Figure 3. In that instance, for the first three sub-tasks, more than half the teachers expected half or more of their students to achieve competence, but expectations were lower for the remaining sub-tasks. Across the two activities, the standout sub-task is the first in the F-2 activity, which involved taking photographs, a skill that it seems increasingly likely for students to have acquired through experiences with mobile phones and tablets in the years before they first entered school. Again, that is primarily a manual skill of manipulating a device, but all the other sub-tasks have more substantial intellectual components.

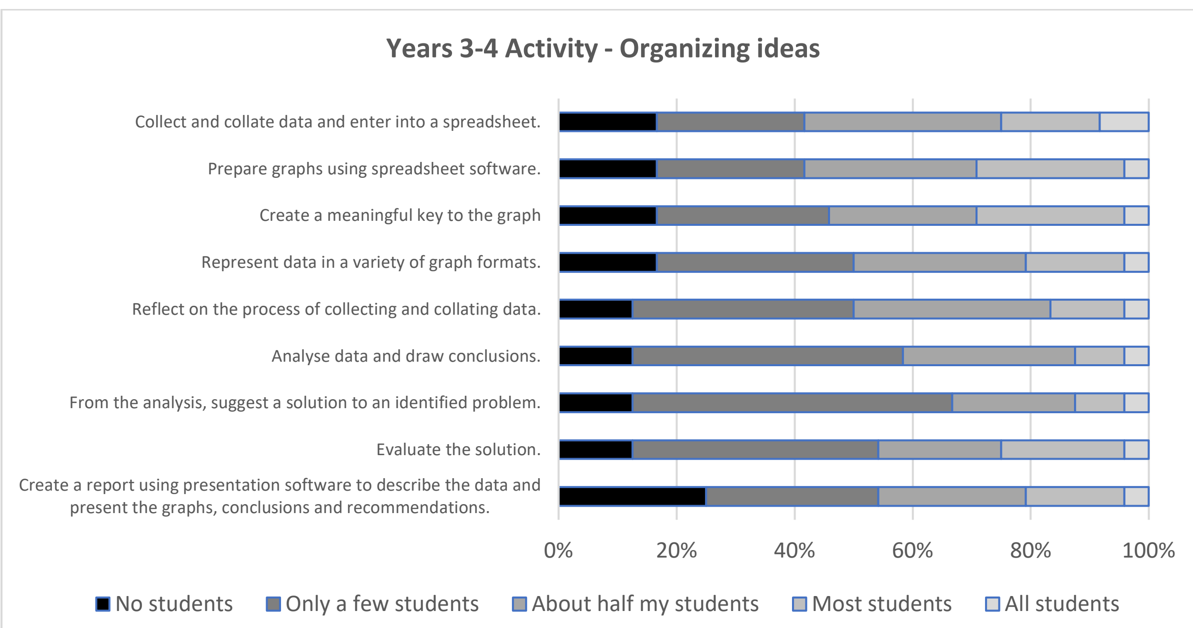

Figure 3. Anticipated student competence on sub-tasks of Years 3-4 Organizing ideas

A second pair of activities that warrants closer examination is ‘Simple robot programming’. Those activities have the smallest gaps (0.5 and 0.4) between the measures of teacher confidence and expectations of student competence, and it seems counter-intuitive that the expectation of student competence for the Years F-2 activity is higher for both performance of the same age group on 'Organizing ideas' and for the Years 3-4 robot activity. Figure 4 presents the distributions of responses for the sub-tasks of the Years F-2 activity. More than 60% of the teachers expect that half or more of their students will achieve competence on all the sub-tasks, though there is a pattern of decreasing expectation that most or all students will achieve competence. However, for the equivalent Years 3-4 task, as shown in Figure 5, no sub-task has 50% of teachers anticipating that half or more of their students will achieve competence.

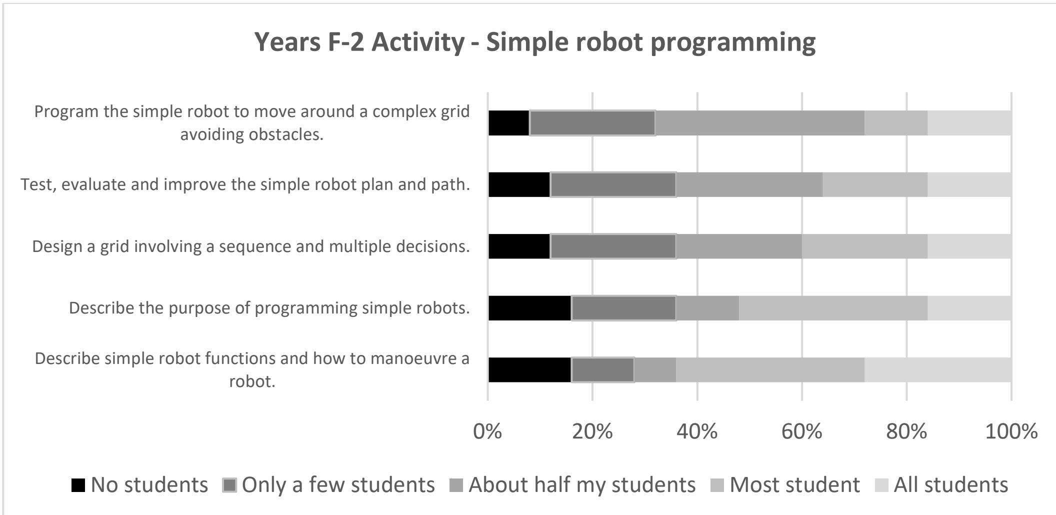

Figure 4. Anticipated student competence on sub-tasks of Years F-2 Simple robot programming

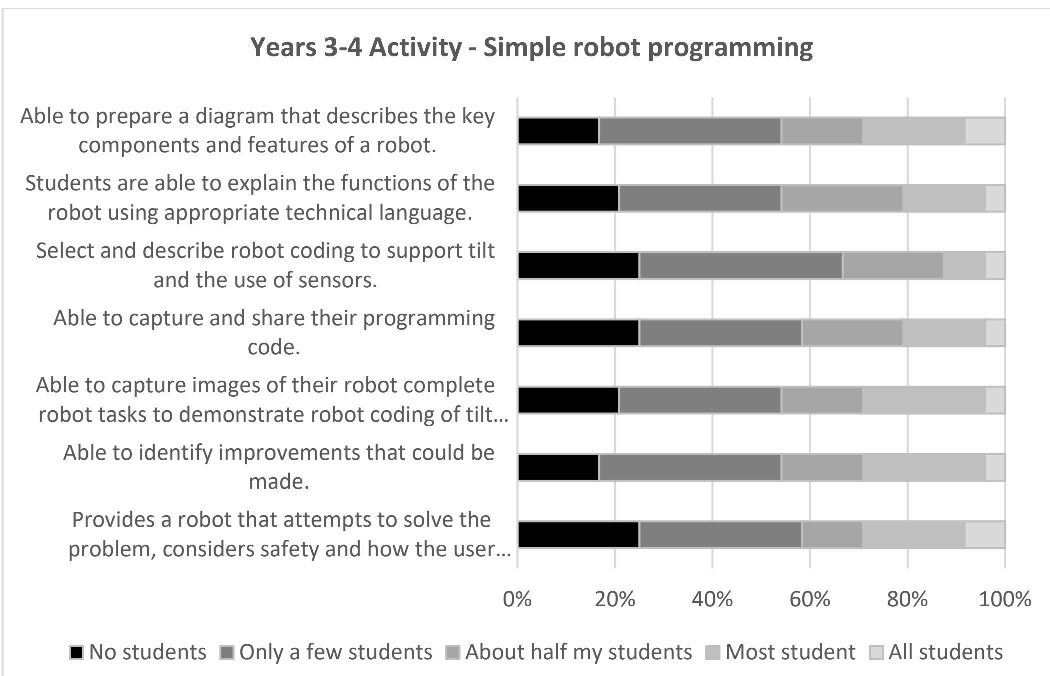

Figure 5. Anticipated student competence on sub-tasks of Years 3-4 Simple robot programming

In summary, most teachers reported being familiar with the digital technologies curriculum, could fittingly distinguish between it and the ICT general capabilities and recognized the importance of using digital technologies for teaching and learning. However, the largest difference in averages between reported teacher confidence and student competence was in the Years F-2 stage, specifically in the first two activities (collecting and describing an object of interest and organizing ideas). Further, the average gap between teacher confidence and student competence was nearly twice the difference in the F-2 stage than the Years 3-4 and the Years 5-6 stages, 1.12 compared to 0.6 and 0.6, respectively. However, self-reported teacher confidence was higher in the F-2 stage with an average of 3.9 and then fell to 3.2 and 3.4 in the Years 3-4 and 5-6, respectively. These findings suggest implications for how teachers plan, teach, and improve their practice.

Implications

The implications of these findings are multi-faceted and, in some cases, specific to the students' cognitive abilities and/or to the level of knowledge required and attained by their teachers. For example, the average self-reported level of confidence in organizing ideas for teachers in the Years F-2 stage was 3.5, nearly the same (3.6) as the 3-4 group of teachers. However, the competence expected in their respective students was vastly different, 2.0 (F-2 students) compared to 2.6 for the Years 3-4 students.

The authors question are these teacher-held assumptions about levels of capabilities based on their students' knowledge of digital technologies or a lack of their cognitive ability to organize these ideas? In other words, is the cognitive task of requiring the organizing of ideas specific to digital technologies beyond Year F-2 students' schema? Because the patterns of student confidence firmly match teacher confidence for the same tasks, it appears that upskilling for both students and teachers is required.

Alternatively, is there an implication that points to the teachers' technological pedagogical knowledge confidence to plan and deliver appropriate activities where the technology is integral to the learning? In either case, the finding suggests that teachers expect their students to develop the capabilities prescribed by the Australian Curriculum to the level of confidence they have attained. Therefore, a recommendation is that teacher professional development in these critical areas may be beneficial to ensure teachers are supported to continually develop their skills, to develop these same skills and core knowledge in young Australians.

Conclusion, limitations, and future research

This study explored teachers' confidence and thoughts on their students' competence in completing the activities as outlined on the Digital Technologies curriculum website (ACARA, 2021). This study highlights those teachers are confident in their abilities, but some students may lack the competence to be able to use these curriculum activities confidently. In the examples shown, students were competent in taking a digital image, but they lacked the skills to be able to process that image and upload it to a classroom blog. This study highlights those teachers do not believe their students would be able to complete most of the tasks for this activity. Some would go further to question if the tasks were suitable for F-2 students as many would have been exposed to taking photos from an early age but would never had been exposed to using the image for anything further than viewing. It does not get better for the Years 3-4 students who would need to be able to create and manipulate a spreadsheet to produce a report including data analysis.

In terms of limitations, the first area of concern is in the data collection. Teachers were invited to participate through social media and the data suggests that most participants were already confident with implementing the digital technologies curriculum activities. It would be interesting to see responses from a wider population of teachers to ascertain the true picture of teachers' confidence in implementing the Australian Curriculum activity examples. This study could highlight that the activities available on the ACARA website may be unachievable by teachers. Several teachers without significant capability could suggest that teachers have developed more personal digital capability, but would that correlate with more participants? Secondly, could a miscorrelation of teacher confidence with student outcomes be pedagogically related or indicate the need to develop contextualization skills in planning and teaching (real-life problems that use the technologies being employed/taught)? Finally, there was no data collected on school contexts and the question to be explored to see if the participating teachers were from similar or like schools or contexts.

Further research suggested could look into how the activities might be implemented in the classroom to understand what effect explicit pedagogy, planning, and teaching professional development could have on the confidence of the teachers for the students to be successful. This could be a two-part intervention research project. Another area for further research could look at the digital capability/competency as one aspect with the connection to digital literacies (cross-device capability, civics, ethics, creativity). This could be extended to understand the implications for ICT general capabilities as well.

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