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Positioning the technologies curriculum: a snapshot of Australian initial teacher education programs

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Abstract

Globally, technology is now a vital element of the school curriculum. Technology has changed the way children learn, and when teachers integrate technology into pedagogical practices, resources, and assessment it expands the way teachers teach. This paper explores how initial teacher education (ITE) programs across Australia position the Technologies Curriculum. It uses data provided at a symposium of teacher educators who deliver ITE in the use of technologies. The paper maps data from 32 universities, including primary, secondary, undergraduate and postgraduate programs. It also investigates the naming conventions of courses in these programs and exemplifies the student experience by providing three vignettes from three programs in three different states. The findings suggest that Technologies education in Australia is offered in many ways to pre-service teachers, thus the landscape of this teaching area is diverse. This paper contributes to the field in being the first research to explore how Australian universities teach Technologies within their ITE programs. It offers a snapshot of how technologies are positioned in Australian ITE programs.

Keywords Initial teacher education · Educational technologies · Curriculum · Technology · Teacher education

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Introduction and context of the study

This brief scoping study outlines some of the key considerations relating to developing technology competence in initial teacher education (ITE). Advances in technology and the subsequent need to prepare students for an increasingly digital knowledge-based world has led to the recognition of technology as a "foundational competency", needing to be taught as a specialist subject and embedded across curricula (Yu et al., 2020, p. 4). Thus the acquisition of digital skills has become a focus of school-based education, and a disconnect has tended to develop between teachers' technical skills and the "practical strategies needed to integrate these skills" into the classroom (p. 3). As a result technological capabilities and literacies need to be taught, evidenced and warranted over time in ITE (Keefe, 2020). Further research in this area is required to understand these changing technology-mediated teaching practices and the literacies and competencies that teachers require in order to translate these into future spaces (so-called actionable and transferable assessment) (Falloon, 2020; McGarr & Gallchóir, 2020). Also, design technology skills and expertise need to be developed to manage tools and materials effectively. Internationally education systems have expected all educators to include technology in their teaching (Shute & Rahimi, 2017). This evolving education landscape demands, from both graduating teachers and their students, the expertise to devise technology-related solutions and the ability to adapt to a rapidly changing digital environment (Fitria & Suminah, 2020). Thus, there are specific expectations on teachers for the teaching of Technologies in Australia.

The Australian Professional Standards for Teachers developed by the Australian Institute for Teaching and School Leadership (AITSL, 2018) are intended to "guide professional learning, practice and engagement, facilitate the improvement of teacher quality and contribute positively to the public standing of the profession" (p. 2). These standards include guidance for preservice teachers to document their achievements at the Graduate level and map what they need to do to move to subsequent teaching practice levels. While some standards do relate to technology-related competencies, the standards do not provide information about implementing these in the classroom.

Of the 37 focus areas of the AITSL Standards, the following three deal explicitly with graduate teachers' use of technology, requiring that graduates can:

- Standard 2.6: use ICT in teaching to expand curriculum learning opportunities;
- Standard 3.4: demonstrate knowledge of ICT resources to engage students, and
- Standard 4.5: demonstrate understanding of the safe, responsible and ethical use of ICT. (AITSL, 2018, p. 13, 14 and 17)

Additionally, many ITE programs relate Standard 4.4, *Describe strategies that support students' wellbeing and safety working within school and/or system, curriculum and legislative requirements* (AITSL, 2018, p. 17), to graduate teachers' use of technology.

Australia is not alone in creating learning standards and outcomes that ensure learners experience a future-focussed education. However, providing technologically literate citizens appears to be addressed in two distinct ways worldwide: through government policy and curriculum documentation, or non-mandated guidelines from not-for-profit organisations.

Like Australia, the UK, Israel and New Zealand governments have mandated curriculum focussed on technology learning. These curricular documents appear to focus on improving students' knowledge and understanding of how computers work, the potential for technologies to solve complex problems, and learners' ability to become technology-competent citizens. In Israel, the government has developed specific curriculum programs to meet the national goal of creating innovation and a technology-based economy. From the age of five, students learn the building blocks of computer coding. As they grow, students learn more complex skills which offer them opportunities to participate in cyber-security or software development industries as adults. Therefore, the prime minister of Israel has connected the national computer school curriculum to its goal of leading technological innovation (Israeli Ministry of Foreign Affairs, 2014).

In some countries, a less formalised approach to developing technology proficiency has emerged. For example, in the United States, a national not-for -profit organisation, the International Society of Standards in Education (ISTE), conducts research and creates developmental frameworks for teachers and students (International Society of Standards in Education, 2021). These frameworks provide guidelines and expectations for what content should be covered and when students should learn it. As a not-for-profit organisation, ISTE does not mandate these standards; instead, they are recommended for teachers and school leaders and this results in its impact being hard to measure or understand.

In the United Kingdom, a similar organisation runs in parallel to the national curriculum statements. JISC is another not-for-profit organisation with a vision to ensure that "the UK [is] the most digitally-advanced higher education, further education and research nation in the world" (JISC, 2019). This focus on higher education begins during school education, and JISC provides the support that enables schools to prepare students for higher or further education.

In reflecting on both ISTE and JISC, their guidelines provide practical frameworks for teachers, but they do not directly measure or influence teachers' learning of technology-related skills and understandings. Compared to the less direct approaches of guidelines provided by not-for-profits, Australia's approach to teaching technology proficiency would appear to have more potential to impact student learning, and learners' and teachers' overall skills and understandings. To date, Australia's curriculum has drawn heavily on the curricula of other countries (Singapore, Finland, British Columbia, and New Zealand), and benchmarks Australian Curriculum outcomes against those documents [Australian Curriculum, Assessment and Reporting Authority (ACARA), 2016]. This positions the Australian Curriculum as a mandated, outcome-driven approach that has national importance. This acknowledged significance requires teachers to be informed and ready to integrate technologies into their teaching with robust pedagogical and content knowledge. It is here that this study is positioned, as we seek to

understand how teacher preparation in technologies is approached across the Australian ITE landscape.

The Australian Curriculum: Technologies (F–10)

The 2008 *Melbourne Declaration on Educational Goals for Young Australians* [Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA), 2008] provided the foundation for the Australian Curriculum. It highlighted the need for Australian students to be empowered to use information and communication technologies (MCEETYA, 2008). The Australian Curriculum: Technologies (F–10) learning area was approved by the ACARA in (2015) as two distinct but interrelated subjects: *Digital Technologies* and *Design and Technologies* (ACARA, 2015), with reporting being first mandated in 2018. As a recently introduced learning area, preservice teachers are required to develop new technology-related knowledge, practical skills and processes. According to the *Alice Springs (Mparntwe) Education Declaration* (Education Council, 2019), teachers need to be "productive and informed users of technology" (p. 5). Much of this preparation falls to ITE programs which must support the development of technology literacies and competencies in preservice teachers (ACARA, 2016, p. 7).

In addition to the Technologies learning area is the *Information and Communication Technology (ICT) Capability.* The ICT Capability supports students to make the most of digital technologies and operate effectively in a digital environment. As an essential component of the overall approach to Technologies education, the ICT Capability is included to provide a more complete understanding of what students (and teachers) are learning "in a world that is increasingly digitised and automated" (ACARA, 2015).

As part of an ongoing Australian Curriculum review process, the Technologies learning area is currently under review, with a new version of the curriculum planned for release in 2022 (ACARA, 2020). As Australian ITE programs are an important marker in the evolution of the Australian Technologies curriculum, this paper explores how they currently position *Technologies* as part of learning and teaching. This insight into the current teaching of Technologies as declared by ITE educators will become the foundation upon which the next generation of programs can be built. This study is guided by the research question: How is the Technologies Curriculum positioned within ITE programs across Australia? The next section of the paper will describe the method and findings from the study. The findings are discussed in light of the literature, and recommendations are provided.

Method

Arksey and O'Malley (2005) explained that a scoping review differs from a systematic review in that it is not focussed on a well-defined question. It is used to map, or provide a snapshot of, existing data. In this case, the technologies subjects are positioned within initial and teacher education programs in Australia. Scoping

reviews can be precursors to a systematic review by identifying gaps in the data as more focussed research questions are generated. For this review, a three-stage process was used for data collection and analysis, incorporating a scoping review, the identification of subject naming conventions, and an exploration of indicative, narrative vignettes.

Stage one—scoping review

The first stage of a scoping review is to identify the purpose and research question (Arksey & O'Malley, 2005). This paper focusses on mapping how the Technologies Curriculum is positioned within ITE programs across Australia, using the research question already identified.

A collaborative data collection activity and desktop review were conducted over one year through a national network that seeks to bring together teacher educators of technologies. This took the form of an in-person workshop where representatives of each institution shared and collated how they taught the Technologies Curriculum in primary and secondary ITE programs at their institution. The information is also available publicly, online at each university's handbook, and did not require specific ethical permission for collection.

Attending this workshop were teacher educators from 32 institutions that provide ITE and represented every state and territory of Australia. They shared their teaching of the Technologies Curriculum to preservice teachers. This encompassed undergraduate and postgraduate programs of study, and all identified subjects forming part of an ITE program. Postgraduate professional programs for in-service teachers were excluded from this study, as they would not help answer the research question.

Through the collaborative document, the teacher educators added details of how the Technologies Curriculum was taught. This included the name of the institution (pseudonyms have been used in this paper), the number of existing subjects, whether they were elective or core subjects, stand-alone technologies subjects or subjects that had technologies embedded, whether they were for primary or secondary specialisation, and whether they were part of an undergraduate or graduate program. The data were collated in an open-access document that was then shared among the teacher educators.

Through the data analysis stage it became apparent that the language used to describe the subjects studied is not consistent amongst institutions. For this paper's purposes, we use the term *subject* to define one unit of study or course; that is, part of a more extensive *program* of study. For example, Digital Technologies in Primary Mathematics, is a *subject* taken as part of the Master of Teaching (Primary) *program*.

The open-access document of data provided the authors of this paper with a starting point to conduct a further desktop study. Each institution's website and student handbook were accessed and subject names and program affiliations were discovered during this stage. For example, where a teacher educator from one institution

had noted that they offered two primary school ITE subjects in Technologies, a search of the institution's online handbook provided more detailed information.

Stage two—identifying subject naming conventions

As well as analysing the Technologies Curriculum's position within each ITE program, the subjects' titles were also examined, as these also position Technologies in terms of associated disciplines and curricular or pedagogical focus. As this positioning impacts not only how the Technologies are viewed and taught but also what students learn, subject titles were analysed and categorised. In addition, synonyms for *technology*, a focus on digital technology or design and technology, and disciplines associated with technology were noted and categorised.

The goal of this research was to explore how digital technologies were taught in ITE programs across Australia. The data from stage one and two were collated into a spreadsheet and then categorised under headings such as; dedicated digital technology subjects, dedicated STEM subjects, digital technologies as a specialisation pathways, embedded in core subjects, and standard alone core subjects. From the data the researchers were able to identify the total number of subjects related to digital technologies taught across the 32 participating institutions along with how many digital technologies subjects were related to primary ITE and secondary ITE programs. These data could then also be visualised independently as a collective. For example, the number of primary subjects with digital technologies embedded in core programs.

Stage three—exploring indicative vignettes

The use of vignettes in qualitative research has the potential to highlight complex data (Wilson & While, 1998). Miles and Huberman (1994) defined vignettes as "a focussed description … taken to be representative, typical or emblematic in the case" (p. 81). To provide a more in-depth exploration of how the Technologies curriculum is taught within programs, the authors, who represent institutions in three different states of Australia, provided vignettes of their programs. The vignettes also helped provide context for the findings. While there may be some differences between institutions, the three vignettes present an initial definition of how technologies are seen to be taught and how the Technologies Curriculum is positioned within ITE programs across Australia.

Findings

In this section, the findings from the three stages of data collection and analysis are presented. First, we present a summary of how institutions have provided elective and specialised pathways for Technologies curriculum learning. After this, we explore the most frequently used approaches to teaching technologies, which were brought together under three emergent categories. These categories are similar to

those used in a study investigating the concept of sustainability in teacher education (Evans et al., 2017).

(1) Elective subjects (completed only by students who choose them).
(2) Specialised pathway subjects (completed by students as part of a specialised learning program, either in technologies, STEM, design technologies or the arts).
(3) Core subjects (completed by all students as part of their program of study). This category was further divided into core technology-specific subjects and subjects where Technologies are embedded and combined with another core subject.

To further interrogate this, we present several short vignettes from three different institutions to provide illustrations of how technologies are included and taught in ITE programs. These vignettes also provide some context for the analysis of the 276 subjects through which Technologies were taught from the 32 tertiary institutions.

Finally, we analyse technologies subjects' naming patterns to understand further how technology teaching is positioned with ITE programs.

Summary of national approaches

The purpose of this paper is to provide a snapshot of the existing teaching of technologies in ITE at each of the 32 participating institutions. It should be noted that, across Australia, all teacher education programs have accreditation cycles but they are not synchronised. This means that at the time of data collection the data were correct; however, at the time of publication that may not be the case. Figure 1, which shows the number of standalone core technologies subjects in both primary and secondary ITE programs per institution, demonstrates the varied responses from the institutions. It was not unusual for institutions to indicate that they provided up to five subjects in which Technologies were taught, and this meant that the analysis was necessarily complex.

Elective subjects

Many subjects were classified as elective subjects, which was the second most common way preservice teachers were likely to engage with the Technologies curriculum. These non-compulsory subjects appeared to offer additional learning in areas such as technologies and design solutions, technologies in the early years, web design and digital literacies for learning. These elective subjects appeared to be connected strongly to either a learning area or a stage of schooling, such as secondary education or science learning.

In total, 38 subjects were offered to preservice secondary teachers across the 32 institutions (Fig. 2). On average, each institution offered between four and five elective subjects that engaged with the Technologies curriculum. Overall, in primary school teacher education, 22 subjects were offered as electives and the participating institutions in this study each provided an average of two elective subjects in Technologies. This contrasts with recent findings that suggest that, out of all of the

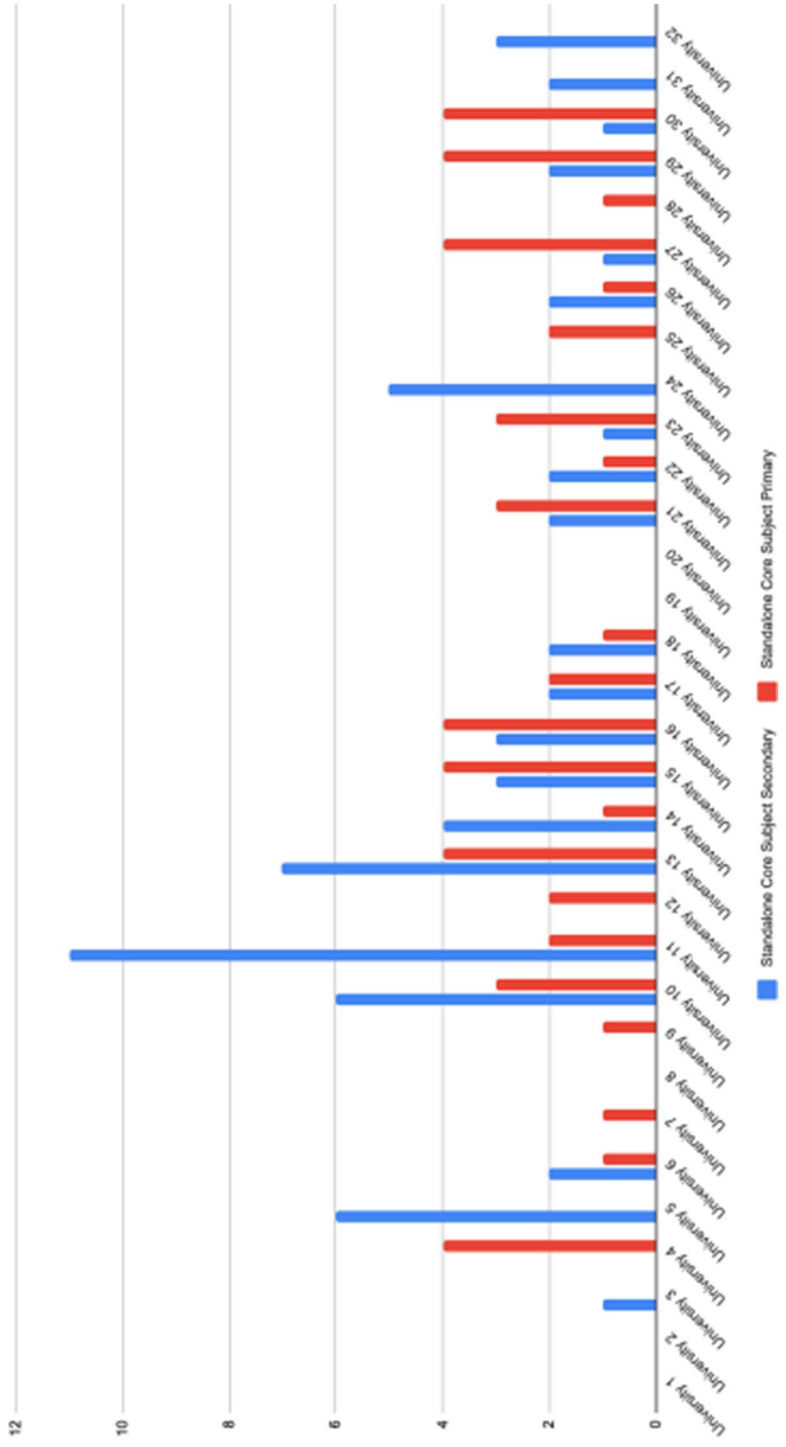

Fig. 1 Standalone core technologies subjects (Primary and secondary)

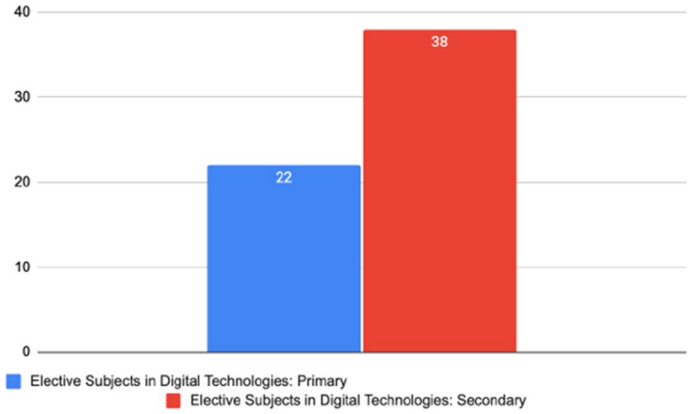

Fig. 2 Number of technologies subjects offered as electives

Science, Technology, Engineering and Mathematics (STEM) areas, Technologies is the least likely elective subject chosen by students (Grobler & Ankiewicz, 2021). The data also suggest that teaching Technologies as an elective, non-compulsory subject is a popular approach in secondary ITE programs across the country.

Specialised pathway subjects

A specialised pathway program offers school preservice teachers an opportunity to graduate with a specialisation in Technologies teaching. In this study of 32 teacher preparation institutions, 23 subjects were identified as being part of specialisation pathway programs for future primary school teachers (Fig. 3). However, only 25% of Australian institutions offer Technologies as a specialised pathway for preservice

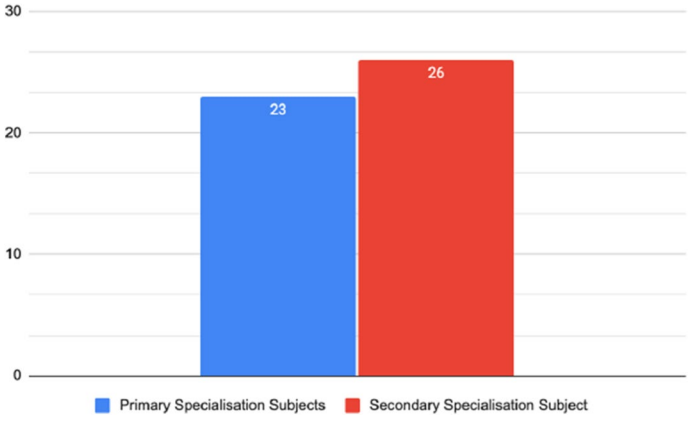

Fig. 3 Number of technologies subjects offered as part of a degree specialisation

primary school teachers. The remaining 75% of institutions appeared to position Technologies teaching as core (compulsory) and elective (non-compulsory) subjects.

In secondary teacher preparation programs, 26 subjects were reported to be part of a Technologies specialisation pathway. Teachers graduating from these programs were qualified to teach Technologies for all year levels in secondary school. It appears from these data that teaching the Technologies curriculum is at times positioned as a specialised field, in both primary and secondary teacher preparation programs.

Dedicated core subjects for technologies teaching

Each of the 32 Australian institutions identified that their programs of study included core, compulsory subjects that had some focus on Technologies. These subjects were provided to all students, regardless of any specialisations, and had to be completed successfully to enable progression through their ITE programs.

Figure 4 presents the number of core subjects that focussed entirely on Technologies. These data indicate that the Technologies curriculum is taught in dedicated core subjects more often in secondary ($n=68$) than in primary ($N=53$) programs.

At some institutions, Technologies outcomes were embedded in other core subjects. For example, the concept of digital pedagogies was embedded into a subject focussed on pedagogies for learning, and a subject focussed on mathematics in the early years addressed basic technological skills and outcomes. When exploring how Technologies are taught within other core subjects, we noted that primary teacher education programs provide more learning opportunities than secondary programs (Fig. 5). This suggests that primary Technologies teaching is positioned as an embedded learning area, more so than in secondary education. Indeed, the limited number of core subjects in secondary education that provide embedded learning about technologies (Fig. 5) represents only six out of the 32 institutions.

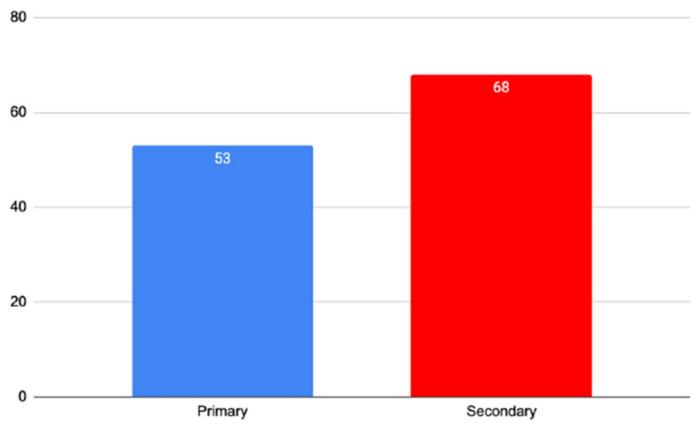

Fig. 4 Standalone core subjects: technologies

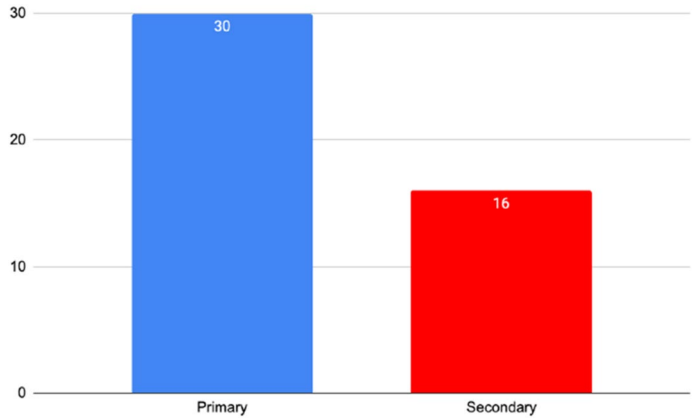

Fig. 5 Technologies learning embedded in core subjects

Vignettes

While core subjects may be the most common way to include technology in ITE, it does not follow that the subjects are positioned in the same way in terms of content. In order to illustrate the complexity in describing technology subjects, vignettes from the three universities the authors represent have been included. While similarities can be seen, they illustrate how the positioning of technology subjects in the ITE map in turn influences the content, as final semester subjects include developing evidence for teacher registration or a focus on the Technologies Curriculum, while first semester subjects focus on confidence and pedagogy. The impact of online versus on-campus delivery and the inclusion of other subject areas, explored further in the following section on naming practices, can also be seen.

Vignette 1: a postgraduate core subject

At Institution A, within the Master of Teaching: Primary, the *Technologies in the Curriculum* subject is typically delivered to preservice teachers in their fourth and final semester. This subject's major focus is on the Technologies curriculum (Prep-primary to Year 6) and its two distinct but related subjects, *Design and Technologies* and *Digital Technologies*. The teacher education subject addresses four main aims. It seeks to provide preservice teachers with opportunities to (a) develop their knowledge of the Technologies curriculum and associated pedagogies, (b) locate and explore a range of digital resources to engage primary-aged students, (c) create an e-portfolio of technology-related evidence based on the applicable AITSL Standards to support job applications and ongoing career progression, and (d) cultivate and extend personal digital literacies, and develop preservice teachers' repertoire of skills and confidence with technologies as a teaching professional.

The primary-focussed Technologies in the Curriculum subject was designed to meet the new Technologies curriculum's evolving requirements. A multi-modal assessment suite was incorporated into the subject, including research using social media, digital tool workshops, and a mixed-reality simulated 'job interview' in which preservice teachers demonstrated their understandings and justified their approach to integrating Technologies into their teaching. Together these tasks served to assess preservice teachers' knowledge of the subject's content, with multiple sources of evidence collected. This provided opportunities for authentic learning and practise of technical skills, as well as providing opportunities to engage in peer feedback and reflection. At Institution A, preservice teachers experience the Technologies curriculum learning as a core subject that must be completed by all students. Another core, dedicated technologies subject is presented as part of the Master of Teaching: Secondary at Institution A. This subject presents a range of computing and mobile technologies, including web 2.0 tools, social media and mobile apps, which are relevant to secondary teaching.

Vignette 2: an undergraduate core subject

At Institution B, Digital Technologies is a first-year core subject for primary, primary and secondary, and primary and secondary health and physical education specialisations of the Bachelor of Education. The primary specialisation has another core digital technologies subject in the third year, but this is the only explicit digital technologies subject for the other cohorts who are enrolled in the Bachelor of Education. This subject is taught on campus in the first semester of first-year when many preservice teachers are adjusting to university life. Preservice teachers enter the subject with varied skills, understandings and expectations of digital technologies. Hence, the subject's major focus is to explore and 'play' with a wide range of digital technologies to develop their confidence and competence. Through the lectures, students become aware of contemporary issues and debates, such as access and equity, barriers to technology use, computational and design thinking, safety and ethics, and the TPACK model. A wide range of pedagogies are introduced and modelled in the tutorials, and preservice teachers are encouraged to think critically about whether the use of digital technologies improves learning in a variety of learning contexts.

New technology is introduced in each tutorial (such as Makey Makey, Microbits, Sphero, Scratch, Augmented Reality, Virtual Reality), and preservice teachers play with the technologies and discuss their affordances and limitations. In the second half of the tutorial, groups of students are challenged to develop a learning activity that addresses at least one curriculum point from the Technologies learning area, one from any other learning area, and the weekly lecture topic. This provides preservice teachers with a way to connect their discipline to digital technologies and incorporate lecture content into their learning activities. For their final assessment task, preservice teachers use a design thinking template to bring together the subject contents to justify, plan, design and teach a learning activity with classmates. They reflect on the activity's success and what they would change were the activity repeated.

Another Bachelor of Education specialisation at Institution B has at least one core dedicated technologies subject. Although it has a similar structure, it focusses on different year levels.

Vignette 3: a core subject and embedded in other subjects

Institution C is a regional university where 70% of the students study online. In the primary undergraduate program, there is a single course in the final year is presented to allow students to gain knowledge, skills and understanding of the *Digital Technologies* and *Design Technologies* subjects of the Australian Curriculum, along with the ICT Capability. The subject uses an interdisciplinary approach integrated with design thinking in which preservice teachers create innovative solutions for authentic problems.

In addition, several non-technology-specific curriculum subjects make links between technological content knowledge and technological pedagogical content knowledge. The professional experience courses, which form the spine of the program, provide additional opportunities for students to gain awareness of the ICT Capability across years 1, 2, 3 and 4 of the degree.

Unit coordinators of these subjects in Institution C reported that digital and design technologies content, such as systems thinking, design thinking, computational thinking, and the use of tools and materials to create prototypes, is unfamiliar to many preservice teachers. This has been found to be similar to experiences in schools where students do not necessarily have the foundational knowledge expected at their year level (Australian Curriculum, Assessment and Reporting Authority, 2018). Having the majority of preservice teachers online also makes it challenging to provide sustainable/cost-effective hands-on activities that offer digital technologies such as BeeBots, Lego robotics and Arduinos.

Future plans are to remove the course's design technologies element and embed it within a science, curriculum and pedagogy course. The course will then focus solely on digital Technologies Curriculum. Currently, at Institution C, students experience technologies learning at the end of their teacher preparation program. The core subject builds on the embedded learning that has occurred in other subjects throughout their degree.

Qualitative analysis of subject naming practices

The titles of subjects were examined to give insights into the positioning of subjects with associated disciplines. In a general sense, the title of a Technologies subject was found to be used to position it within the ITE program in terms of its focus and the curriculum areas that were subsequently linked with Technologies. While this has the potential to impact the way the Technologies learning area is taught, it is also likely to influence students' understandings of how and where technologies are situated in terms of an integrated curriculum; merging technologies with science would send preservice teachers a different message about how technology can be integrated, compared to integration of technologies with a subject on art.

Fig. 6 Common title terms in primary subjects

Fig. 7 Common title terms in secondary subjects

In primary-level subjects, titles that included technology terms were much more likely to be linked with other disciplines, particularly science and technology, than in secondary-level specialisations. However, numeracy, literacy, arts and/or humanities were also found in subject titles. Subject titles that had no reference to technologies, design, digital or synonyms in their name were commonly science or literacy subjects in secondary, and numeracy subjects in primary. Primary and secondary both had subject names that were tangentially linked to Technologies and emphasised the future of teaching and learning, and strategies for effective teaching and learning related to professional experience. Terms that reflect the Technologies curriculum, such as *solutions*, were found in both primary and secondary subject names, but *creativity* and *principles* were only found in primary subject names, along with terms such as *discovering*, *integrating*, *fundamentals*, and even *toys*.

In primary and secondary subjects, terms indicating the teaching of the Digital Technologies subject included *computer*, *IT*, *ICT* and *STEM*, and terms referring to a specific aspect of technology such as *programming*, *coding*, *internet fundamentals*, *robotics* and *systems* or *web design*. One secondary subject name included the term *TPACK*. In secondary subject titles, the term *design* was paired with *spatial*, *experimental*, *materials*, *systems* and *thinking*, which relate directly to the Design and Technologies Curriculum. Even when there may have been no direct reference to design or technology in the title, there was a strong focus on food, hospitality and nutrition, livestock production, and materials related to the food and fibre production and food specialisation contexts of the curriculum. This was not found in primary subjects. However, it was unclear how some subjects such as the Ecology of Children and Families 1 (secondary) included technologies. Figures 6 and 7 show the data after the expected terms, such as *digital*, *design*, *technology*, *education*, *curriculum*, *pedagogy*, *teaching* and synonyms, were removed. They illustrate the different alignment of technologies in primary and secondary technologies subjects.

This examination of the subjects' titles indicates differences between primary and secondary subjects in how technologies are positioned within ITE. Primary subjects were largely associated with science, whereas secondary subjects were more closely associated with food and materials, indicating the Design and Technology Curriculum.

Discussion

This study offers insights into the range and variety of Technologies Curriculum teaching that preservice teachers experience. This has a direct impact on their abilities to teach and meet the Australian Curriculum outcomes related to Technologies. How the Technologies curriculum is taught within teacher education programs impacts how preservice teachers will teach Technologies when they graduate (Admiraal et al., 2017). The Technologies curriculum and the associated ICT Capability are relevant for secondary and primary teacher education programs. The findings from this study indicate that there is a wide range of approaches to Technologies education at the tertiary ITE level. Technologies are embedded in a mixture of elective subjects, core technology subjects, other (non-technology-specific) core subjects and specialised pathway subjects. Overall, 276 courses were found to be related to Technologies across Australian ITE programs. Of particular note, on average, there are more than eight subjects per program, would could be regarded as surprisingly high. Table 1 provides a summary of the technology-related subjects delivered as part of Australian ITE courses.

The data indicated that the most common approach for offering Technologies was through a Core Technology subject ($N=121$) in both Primary ($N=53$) and Secondary ($N=68$) programs. This parallels the findings of Foulger et al. (2019) who also found that most teacher education programs used a stand-alone course to teach Technologies. There is also, however, research indicating that a core subject alone is insufficient to equip preservice teachers to effectively engage with Technologies (Karatas, 2014; Polly et al., 2010).

The second most common approach to teaching Technologies Curriculum knowledge and skills was through elective courses ($N=60$) when considering both primary and secondary subjects, with primary programs having 22 subjects and secondary having 38 subjects. This was also the second most common approach to teaching Technologies in secondary programs. This is concerning,

Table 1 Overview of technologies subjects taught in ITE

Course type	Primary	Secondary	Total
Elective subject	22	38	60
Core technology subject	53	68	121
Embedded in core subjects	30	16	46
Specialised pathway subjects	23	26	49
Total courses	128	148	276

especially because those secondary subjects were not compulsory. These findings pose questions about what messages are being sent to preservice teachers regarding the importance of Technologies within the school curriculum. There are two possible interpretations for these data. Firstly, the lack of secondary core subjects may position technologies learning as not compulsory, creating a challenge for technology teacher educators. On the other hand, learners who take these non-core subjects may instead feel they lack necessary technology skills, unlike their peers who are seen already to possess technological knowledge and skills.

In Australian primary teacher education programs, the second most common teaching approach for the Australian Curriculum: Digital Technology was by embedding Technologies into core subjects ($N = 30$). In contrast, in Australian secondary programs there were only 16 occasions where the program had embedded Technologies within a core course. This included discipline-specific curriculum courses and pedagogy courses. This approach's advantage is that preservice teachers see different models of Technologies from a range of faculty members (Brenner & Brill, 2016). It also allows for Technologies knowledge and skills to be connected to the preservice teachers' learning of curriculum and pedagogy (Admiraal et al., 2017). It also seems that infusing Technologies into pedagogical courses aligns with the Technological, Pedagogical and Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). Foulger et al. (2019) support this approach.

Specialised pathways provided 23 examples in the primary programs and 26 in secondary programs. However, the specialist pathways courses are only taken by teachers who will specialise in Technologies teaching. This finding may have implications for teachers, because if they see themselves as not being specialists, then they may not engage with Technologies in their learning area. A more cautious reflection, however, suggests a need for closer interrogation and further research to explore whether pre-service teachers who do not pursue specialist pathways are less likely to deploy technologies in their own teaching area.

It is not surprising, however, given that secondary educators tend to be discipline experts, that there is a range of Technologies-related subjects in secondary education. Research investigating technologies instruction for music educators found that 63% of preservice teachers had taken a core technologies course during their undergraduate degree program (Hanging, 2016). Yet, within the ITE program, the core technologies courses were most commonly taught by the college/school/department of music. Hanging's study highlighted the discipline-specific learning of technologies software, such as software for music compositions or sound mixing.

In contrast, during an English teacher education study in the United States, 46% of the participants claimed that technology was integrated across a program, whereas 27% suggested that their technologies skills were taught in a core course (Pasternak et al., 2016). In a study about Technologies in physical education, Gawrisch et al. (2020) commented that there was a deficiency in the number of technologies-proficient teacher educators, which in turn impacts the quality of the learning for preservice teachers.

Limitations

The major limitation of this study is that the language used by universities across Australia is not a shared language. The researchers have interpreted the data through the lenses of their own expertise and knowledge in the space. Although having one researcher conduct the initial analysis and then bringing in co-authors/researchers from different universities in different states has gone some way towards mediating this potential bias, we recognise that this is indeed a challenge for making comparisons about Technologies in ITE.

Conclusions

This paper explored the teaching of the Technologies Curriculum across all Australian states, thus providing a snapshot of what Technologies education looks like in Australian ITE programs. In answering the study's research question, How is the Technologies Curriculum positioned within ITE programs across Australia?, it was found that preservice teachers are most likely to have experienced the Technologies curriculum through core technologies subjects, with electives being the next most likely experience. In the primary specialisation, Technologies are sometimes included in science courses, and in secondary specialisations, they are sometimes combined with food or materials courses. This research has confirmed that Australian ITE courses are yet to have a coherent approach to teaching the Technologies Curriculum. The range of approaches to teaching and assessing the Technologies curriculum across the 32 universities included in this study provides a unique snapshot of how they appeared when the data were collected. The literature is conflicted about the most effective way to teach Technologies in ITE, as are ITE programs' practices across the world. This suggests that one single approach to learning is unlikely to meet all programs' needs in all locations. How technologies are positioned in ITE programs impacts preservice teachers and the school students they teach. For example, consider the debate around the inclusion of Arts in STEM (Science, Technology Engineering and Mathematics) to create STEAM (Mejias et al., 2021).

Currently, in Australia all ITE programs have the option to address the mandated subject matter in their own way, as ITE programs are empowered to present their programs in a manner that best suits their program goals and student cohort. Implications for practice can be seen in the creative approaches alluded to in this study that consider knowledge and skills of both the ITE educators and the ITE student cohorts. Therefore, despite each of the programs having undergone rigorous national accreditation in terms of the content and assessment standards as determined by AITSL, a balance between institutional autonomy and fulfilling requirements of the curriculum is needed.

As the Technologies Curriculum was introduced into Australian schools in 2015, it will not be until 2029 that we can expect to see preservice teachers

who experienced the full breadth and depth of the Technologies curriculum as part of their primary and secondary schooling. This is important, as research on out-of-field teaching indicates that a teacher's knowledge that builds upon their own experiences, impacts how and what they teach (Ríordáin et al., 2019). This suggests there will continue to be a long-term disconnect for preservice teachers between their own experiences of Technologies learning in schools and their preservice teacher studies.

In addition, institutions must also address the complex landscape of constantly changing technological tools available to education and industry. Indeed, some software, hardware and apps become redundant and new ones appear on the market on a regular basis. This perhaps implies that at least some teachers are unlikely ever to feel entirely comfortable with the digital tools available for learning and teaching. This wicked problem is exacerbated because teacher educators teaching the preservice teachers do not always have the content knowledge or skills demanded by the Technologies curriculum [Krumsvik, 2014; Organisation for Economic Co-operation and Development (OECD), 2010]. There is a continuous cycle of change both in the Technologies Curriculum and in the technological tools available. Naturally occurring resistance to the complex problem means that it is likely to remain a wicked problem.

Future questions to expand this study could ask: What types of technologies and/or pedagogies are prioritised in ITE in Australia? It would also be valuable to investigate how technologies are positioned in different discipline areas and what messages this sends to preservice teachers. A complementary study might explore a comparison with other national programs of learning and teaching.

This paper contributes to the field by being the only research to date to explore how Australian universities teach the Technologies curriculum within their ITE programs. It offers a unique snapshot of how technologies are positioned, providing a range of insights, along with the posing of a number of questions. The study highlights the complexity of the discipline- knowledge, skills, tools, and devices required and how programs are impacted by the constant change of these items. Of perhaps greater consequence is the need for increased balance between institutional autonomy, the skills and understandings of ITE educators in the area of Technologies, the needs of preservice teachers to teach what they may not have experienced themselves, and expectations around meeting AITSL Standards in the delivery of the Technologies curriculum. Given that 32 institutions have devised their own individual approaches to Technologies education, it is suggested that more could be done in terms of a coordinated national approach to support ITE programs, whilst at the same time respecting institutional autonomy. Perhaps more emphasis could be applied within ITE to recognise technology as a foundational preservice teacher competency as well as a curriculum learning area that must be covered to meet AITSL Standards. Perhaps such an approach could help to bridge the persistent disconnect between teachers' technical skills and the pedagogies that will make a substantial difference in the classroom.

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