

Technology Teacher Education - Requirements

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Introduction

What is the role of teacher education in preparing and supporting teachers of technology education? Before student teachers can even consider teaching technology education they need an overarching, holistic view of the purpose of technology education in the curriculum, as well as what technology is and how it impacts and influences our world, people and environment. They also need to understand the role content, pedagogical and pedagogical content knowledge (PCK) play in developing quality technology education teachers.

Teacher education occurs at two levels, one in initial teacher education (ITE) programs where students are taught the fundamentals of teaching technology at early childhood, primary or secondary school level. The second is in-service teacher education, targeted at practising teachers, aimed at keeping them abreast with changes and contemporary understandings of teaching and learning. This entry's main focus is ITE and is based on the premise that student teachers come to technology classes in ITE programs with wide-ranging understandings of technology and little knowledge about pedagogical practices.

In their development of the Pre-service Technology Teacher Education Resource (PTTER) framework, Forret and colleagues (2011) identified four cornerstones for quality technology teacher education. These are that to teach technology successfully teachers need to understand the philosophy of technology, have a strong rationale for teaching technology, understand the underpinning ideas of the technology curriculum, and plan and implement it using sound pedagogical practices. This entry is structured around these four cornerstones.

Throughout this entry, technology education refers to the school curriculum learning area of design and technology. Teachers teach technology either in early childhood centres, primary schools or as specialist teachers of technology in intermediate or secondary schools, including junior and senior levels.

Developing a Philosophy of Technology

In the development of the PTTER framework, Forret and colleagues (2011) established that to teach technology successfully student teachers and teachers need to know and understand the philosophy of technology. De Vries (2005) suggests that early philosophers *about* technology focused on the relationship between technology and people or society but more recently the philosophy *of* technology focuses on what technology is. Both these aspects are important and need to be understood in order to teach technology effectively.

When asked what technology is, many people refer to technology as artefacts, typically high-end electronic and digital technologies. Most people consider that technology is a relatively

recent phenomena. For successful teaching it is crucial to hold an holistic understanding of the nature of technology, which is considerably broader than these two ideas on their own.

Technology is an innate human endeavour. You only need to give a group of pre-school children a set of blocks and sticks and watch them build to understand this. Since the dawn of time humans have intervened in the natural world by designing and modifying their environment to make life easier or to increase their capability. They have identified and deployed a range of resources and materials to make tools and develop processes, and manipulated materials to solve practical problems. It involves identifying a specific problem or recognising an opportunity. Technologists (people who design and develop technologies) then undertake technological practice to develop an outcome to solve the identified problem or realise the recognised opportunity. It includes the development of artefacts or products, systems and processes.

However, fully understanding technology does not stop there. For example, as people become aware of a range of medical issues caused by exposure to certain materials, as global warming increases, and other environmental issues arise we begin to understand that people and technology are having a devastating impact of our planet and those who live within its bounds. Consider the technological innovation of plastic. Once it was hailed as a miracle material known for its strength, variety, flexibility and longevity. We are now understanding its long-term impacts on the environment. In response, many people are beginning to be more discerning about their use of plastic. Single-use supermarket plastic bags are being replaced with reusable fabric bags, paper straws are slowly returning, sandwiches are being wrapped in wax covered fabric and many of the plastics we do use are recycled. And these changes all involve technology. Technology is therefore not just about designing and making ‘stuff’. Technology includes understanding the impacts technology has on people and the environment. Technologists need to understand that they should not always design and make anything. Understanding current and future environmental and societal impacts and implications are vital components of technology education.

The relationship between technology and society is complex; technology not only has direct impacts on the lives of humans, but in turn they influence technological development. Technology selection and use is influenced by culture. Take the simple example of washing the dishes. Although a simple task that many of us undertake on a daily basis, it is culturally bound and therefore influences the technological products and systems people engage with. Following a food technology lesson with a group of secondary ITE students, Wendy (one of the authors) reminded them to do the dishes. A student from India said to her,

“Here, you do the dishes in a funny way!”

“What do you mean?” she replied.

“Well, you fill a sink with hot water and dishwashing liquid and put all the dirty dishes in that water to wash them. When washed you dry them with a tea towel.”

“Isn’t that how everyone one does the dishes?” Wendy asked.

“Oh no!” the student said, “In India where I am from we rinse all the plates under running warm water from a tap, put a little soap on each dish and again wash them under a warm running water. No tea towels, the dishes are then left on the bench to dry.” Wendy pondered this response and then said,

“If I did that here I would use all the hot water and have to have a cold shower at night.” The student smiled and replied, “Oh yes! Where I come from in India it is so hot that when I ran the tap the water was always warm.”

Sharing this story with other ITE students has identified other culturally-situated stories of dish washing. In England dishes are often washed in a plastic basin in the kitchen sink, in others dishes are washed only once a day when water is delivered to the house. This story illustrates the integral relationship between culture and technology.

Understanding a Rationale for Teaching Technology

In the previous section we identify technology as an innate human endeavour. To pursue this endeavour, technological capability is required – the ability to envisage how the world might be different, and to take action to bring about that difference. As with other innate capabilities, such as our ability to communicate with language, we are born with a latent capability that has to be nurtured in order to flourish. Schools have the potential to develop this capability, ensuring that all children, whatever their life circumstances, are able to develop technological competence and confidence. Developing technological capability that allows young people to engage productively and creatively in the made-world should be seen as an entitlement, bringing both personal and societal benefits.

Providing for this entitlement through formal schooling highlights the importance of teachers having sound philosophical understandings of technology. This enables them to understand how cultural values and beliefs influence the technologies students engage with and therefore what technological outcomes their students could design and develop. This sound philosophical base assists teachers’ understanding of the wealth of cultural knowledge students come to class with, thus facilitating culturally-responsive, inclusive practices. A rounded holistic technological capability allows children to believe that they have (or can acquire) knowledge and skill to design and create a specific technological outcome. But it is important that their knowledge and skills include the ability to critique - to make judgements about the impact of their proposed outcome and whether or not it *should* be created. Teachers need to recognise the intrinsic, personal value for a student in successfully engaging in technological practice alongside understandings of extrinsic realities such as economic, cultural, environmental and ethical impacts.

As indicated earlier, the word ‘technology’ encompasses a broad spectrum of knowledge and skills, from what are sometimes called primary, or first generation technologies (artefacts and processes that have existed from early civilisations, such as working by hand with wood, metal, textiles and food), to digital technologies that are now seen as a driver for the fourth industrial revolution. Supporting both intrinsic and extrinsic motivations, there is a strong rationale for

an entitlement for young people to understand and engage with technologies across this spectrum. Worryingly, the experiences of physical making that stem from early technologies are being eroded by the digital, potentially causing what the weaver Anni Albers referred to as 'lop-sided' development as we lose the tactile experiences of making by hand.

Technology education has a unique place in schools to prevent such lop-sided growth. With the physical and digital worlds of making sitting alongside each other, they can be intertwined in technological activity affording young people opportunities to build an interconnected understanding of technological knowledge. Technological practice doesn't exist in a vacuum – there is always a 'real world' context, from innovating to deal with problems of global warming to exploiting an opportunity to use a new material that will make stronger, lighter sports equipment. Ensuring that school technological activities are embedded in real-world contexts allows for a further intertwining of knowledge. Teaching and learning technology exploits this wealth of learning opportunities. Where else in the curriculum does such possibility exist? But providing the richness that is possible depends on a clear vision of curriculum.

Understanding the Curriculum

This entry discusses aspects of curriculum critical in planning and implementing technology education. Many but not all nations have included technology in their national curriculum. How it is situated varies. In some jurisdictions it is a learning area in its own right. In others it is combined with science. Some have a 'high tech' digital focus; some include food and textiles and others do not. Craft is closely related to technology in some curricula and in others technology is combined with engineering education.

Education policy is intended to influence education practice. Teachers need to understand their national or state curricula and the place that technology plays within it. They also need to understand teaching and learning theory that underpins that curriculum. In technology education effective pedagogy encompasses a number of critical elements, not necessarily unique to technology but particularly relevant given its practical-academic duality. Technology curricula world-wide focus on interaction and intervention in the made-world. Students' technology practice must be as authentic as practically possible to that of technologists. Technology education lends itself to future-focused inquiry-based approaches to teaching and learning. A critical aspect of successful teaching, especially in an inquiry-based program, is the need for teachers to be reflective practitioners, engaging in systematic and critical inquiry into their own and others' practice. Student teachers need to be taught the value of reflective practice and supported to develop capacity to do so. A goal of reflective practice is to ensure that teachers are providing the best education possible for every student. This involves reflection of their own practice in relation to students' learning. Student technological practice should therefore be based on design and development processes, while reflecting and acknowledging their own cultural knowledge, beliefs and values and that of their stakeholders and potential

end-users. In other words, learning contexts must consider appropriate and inclusive cultural practices.

Student teachers should also understand the impact the learning environment has on their ability to deliver technology. The technology learning environment reflects schools and teachers' philosophies about teaching and learning in technology. For example, if technology rooms are divided into different areas such as wood work, metal work, food, textiles or ICT, students quickly get the message that technology is made in one or other of the spaces and with specific predetermined materials. Rather, facilities based on a constructivist, inquiry-based model of learning could be structured in a way that facilitates flow and connection between specialist spaces, giving students the message that materials and processes used will depend on their project requirements rather than the "room" they happen to be in for that lesson. Technology teachers in early childhood and primary regularly work across a range of materials, areas and processes. Likewise, secondary technology teachers are increasingly finding themselves working across a range of the areas of technology such as foods, biotechnology, soft materials and textiles, resistant materials, digital technologies and control technologies. With the assistance of their teachers, students undertake technological practice using the specialist teacher knowledge, facilities, materials and processes required for each specific project.

Reviewing teaching and learning is an integral part of education. In technology an added complexity is the review of programs of work. Each technology area has associated specific skills and knowledge critical to enable students to develop quality technological outcomes in that area or across multiple areas. There are also generic skills and knowledge that are common across the areas of technology, such as designing and modelling. When planning and reviewing their classroom programs, teachers need to work together to ensure that generic skills are being developed and reinforced progressively as students move between authentic projects across multiple technological areas.

National curricula may assist or hinder this approach, as can school facilities, the philosophical beliefs and understandings of senior management in schools, and high stakes assessment requirements. However the greatest influence on students' ability to undertake authentic technology practice is that of the individual teacher. The next section explores ways to successfully implement future-focused technology education.

Implementing the Curriculum

In whatever context a person is becoming a technology teacher, whatever the nature of the local, provincial, state or national curriculum, their contribution will be what happens in their classroom. Early in this entry we pointed out the importance of student teachers developing understanding of the roles that both content and pedagogy play in providing quality learning and teaching experiences. This understanding will underpin effective teaching practices.

Effective teaching practices have common features across age groups and disciplinary borders,

but each discipline also has distinctive characteristics that affect learning and teaching. In outlining a rationale for teaching technology we highlight the extent to which technological endeavour is a feature of being human and that technology education develops capability in bringing together knowledge, skills, and dispositions (including the development of criticality) to envisage, design and create artefacts, systems and environments. Developing this capability is not straightforward as the contexts in which such capability is developed can be complex. Kimbell and Perry (2001) highlight the distinctiveness of technology education, focusing specifically on three interrelated aspects. The first is that activity is based in projects where ideas are developed to meet a need, take advantage of an opportunity, and create something new. Second, at the centre of projects are 'wicked' tasks that are complex, full of competing priorities and uncertainties and that have no right or wrong answers, just outcomes seen as better or worse depending on the viewpoint taken. These first two distinctive features then impact on the third: that the knowledge and skills needed are derived from the task, not predefined in advance. Taken together, these provide insights into why technology education requires students to engage in authentic 'real world' challenges. They also indicate the challenges for new teachers in implementing an effective technology curriculum.

Successful implementation of a curriculum depends on planning, enacting and reflecting on teaching and learning experiences at three levels: a macro level (overarching aims and approaches), a meso level (pedagogic approaches that can be applied to achieve aims) and a micro level (specifics of a single learning experience or lesson). For student teachers it can be difficult to see the wood for the trees when beginning to implement a technology curriculum, holding both the big picture and the small details together in a coherent manner. Educators and researchers in technology education have created a range of frameworks to support practice. Three are outlined below.

The first is an overarching framework for learning and teaching that is compatible with the distinctive nature of technological activity. Claxton, Lucas and Spencer (2012) took the concept of 'studio' teaching as providing seven key dimensions to consider in creating an effective learning environment. Each dimension is set on a continuum that enables both planning and reflecting on teaching practices. The first of these is the role of the teacher – at one end of the continuum the teacher is didactic, at the other facilitative – with a more facilitative role matching a studio teaching concept. Their further dimensions speak to the nature of activities. Are they authentic or contrived? How is time organised – is it extended or bell-bound? How is space organised, like a workshop or classroom? What are the levels of interaction – do students work in groups or individually? How visible are the learning and teaching processes? And is the role of the student self-managed or directed? The concept of the facilitative, authentic, extended workshop environment with high visibility of processes and self-managed students may seem like an ideal, but the dimensions in the framework provide lenses to plan and reflect on learning experiences, while the continuum for each allows for decision making about where on a continuum it would be appropriate to place an activity in order to meet the immediate needs and opportunities for teaching.

The second framework looks at the pedagogic purpose, actions and tools of a learning and

teaching episode – what would be most helpful for a student to do at any given point in their project. Stables (2019) suggests that these purposes can be focused in a number of ways. In order to move their project forward does the student need to speculate about possibilities, create images or models of their ideas, critique their existing ideas, find some new knowledge, learn a new skill, explore materials or maybe collaborate with others? Once the purpose of the next step is identified, a teacher can consider the pedagogic actions that could be taken. For example, if students are critiquing their existing ideas the pedagogic action could be to identify the values to be considered. Pedagogic tools that could help might include creating a user profile, simulating a role play of their product in use, or building scenarios of different people using their ideas.

The first two frameworks provide structures for overarching planning. The third looks much more specifically at learning outcomes in the context of technology education. Jones and Moreland (2004) drew on previous work identifying four categories of specific learning outcomes that when integrated in technological projects, enhance technological literacy: technological concepts, procedures, societal aspects and technical skills. Their research showed that the framework helped teachers achieve balance within lessons and also supported ways in which teachers could plan for progression and assessment on a lesson-by-lesson basis. In addition, the framework gave teachers a basis for sharing and discussing how they implemented the curriculum with colleagues using the same framework.

These three frameworks are not the only ways to structure and implement a curriculum, but they provide key features that create a set of lenses to consider the overall approach to structuring learning, making decisions about pedagogic actions and creating balance in what is being learned.

Conclusion

This entry has set out introductory and fundamental ideas necessary for developing teachers of technology who have sound philosophical and theoretical understandings of technology education. These include knowing and understanding the nature of technology, the rationale for teaching technology in all schools, the nature and purposes of curriculum in technology education and approaches to implementing such a curriculum. See Reinsfield, this volume, for a discussion about the tensions that can arise around best practice in ITE, Lee for some of the issues that need to be addressed, and Boodhoo for thoughts regarding assessment. Atkinson, Bunting and Reinsfield, de Vries, Gumaelius & Engström, Ritz, Seery, and Williams and Pagram outline the challenges for technology teacher education in England, New Zealand, The Netherlands, Sweden, USA, Ireland and Australia. Together, these entries provide a spectrum of insight into how technology teacher education has developed in a range of international contexts, presenting a diverse richness of ideas and approaches to inform teacher and teacher educator practice.

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