CHAPTER 7

Technological concepts and technical contexts for technology education

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How do you describe the content of technology education?

I have struggled with this question for about 10 years. As an undergraduate student in the Irish educational context, I studied two *subjects* from the national curriculum. The terminology around the subjects have shifted in recent years, but in 2011, I was studying to become a Materials Technology (Wood) and Technical Graphics teacher. The origins and trajectory of technology education in different national contexts has been well charted, and the Irish context mirrors the vocational past found in many countries around the world (Banks & Williams, 2022). While an in-depth discussion on this history is beyond the scope of this chapter, it is important to note. The relevance here stems from the clarity through which the *content* of these previous subject may be represented. As the primary focus was on the preparation of learners for the world or work, the skills, knowledge and competencies associated with wood- and graphical communication-oriented professions formed the primary content of subjects. With the development from vocationally oriented technical education, technology education is instead presented as a learning area of importance for all learners. While the goals for technology education are well articulated, and have been for some time, the perennial debate in technology education is the stymied transition from technical education. It is my contention that the technical contexts that defined vocational education, which are still present in curricular representations of technology education, contribute to these tensions.

In this chapter, I seek to problematise representations of the *content* of technology education. While this approach may at first appear like a step backwards, towards a more archaic conception of curriculum or indeed teaching, the nuance lies in how *content* as a concept may serve as delineator between technical and technology education. Based on my PhD research (Doyle et al., 2023) with educators in Ireland, Sweden and New Zealand, three different approaches to conceptualising technology education will be presented. The implicit representations of *content* within each conceptualisation of technology education will then be problematised and discussed relative to technological concepts and technical contexts (Rossouw et al., 2011). The chapter will conclude with some questions intended to prompt discourse on how *content*, and in turn learning, may be articulated in technology education.

Difference: The role of technical context

Technical education (see Keirl (2017) for more detail on the distinction between technical education and technology education) was developed with an industry-oriented agenda. Dakers (2022) notes how this approach ultimately manifested in a two tier education system based on meritocracy. The transition from primary education to secondary education was also the point at which learners were separated. High achievers were placed in an academic pathway, and other learners were placed on a vocational pathway. Whereas the academic route focused on the development of the learner, the technical education approach held a vocational agenda whereby the service of industry was the primary motivation. More detail is not required here as this history and implications are well charted (Buckley, 2023). However, if we return to our opening question, *how do you describe the content of technology education?* the distinct heritage of a technology education that's evolved from a technical predecessor is worthwhile exploring. The challenge here stems from the clarity through which the *content* of these technical predecessors to technology education may be represented.

The vocational agenda inherent to technical education, manifested as a very specific curriculum, and in turn, *content*, that could be articulated. As the purpose of such subjects was to prepare learners for the world of work, in a specific trade, then the knowledge, skills or competencies associated with this trade can be organised and articulated as content. In a similar way to how the pedagogical approach of early attempts at technology education followed that of the master apprentice model of

the medieval guild (Banks & Barlex, 1999), the *content* followed a specific series of skills development (Doyle, 2023). In place of the broader goals of technology education, the content of specific vocations dictated the content of curriculum. If the technical context, in this case defined by vocation is changed, then the *content* changes also. Wood as a material is changes to food, and a discussion around appropriate angles at which to cut dovetails in hardwood versus softwoods is shifted to a discussion around the effects of humidity on proving times. As noted earlier, this historical context and the implications on technology education today are well charted, and so I will not devote further time to this here. Understanding the heritage of different technology educations is important if we want to problematise today's representations. Where this discussion becomes particularly interesting, is if the role of technical context is considered relative to multiple technology educations. As such a discussion requires one the ask questions about the different, but more importantly the commonality between Food and Wood as *contexts* for technology education.

It's worthwhile pausing at this stage to consider the use of the word 'content' to discuss technology education. If you have read this far and are slightly uncomfortable with its use I understand. I know that I am. Having worked in Initial Technology Teacher Education for several years now I am always apprehensive to use the word. I have been conditioned or conditioned myself away from its use. I suspect this apprehension stems from the difficulty in demarcating the limits of well understood content associated with technical education, and concisely articulating the content of technology education.

Despite my discomfort with the use of *content* to adequately describe technology education, I found myself asking a participant about the content of technology education in an interview as part of my doctoral research. The question arose towards the end of an interview in which the participant had, in a very articulate manner, described the nature of teaching and learning in their technology subject. Following this, the participant was reflecting on a peer teachers experience of covering a technology class and their discomfort with the apparent mayhem that was occurring. The covering teacher, in this case a mathematics teacher, found it difficult to reconcile that all students could be engaging with very different activities in the technology lesson. This was not an issue for the participant, as I suspect it is not an issue (or at all surprising) to any technology education professional. In any case, the covering teacher in this instance could not reconcile the apparent sporadic nature of student

activity. When comparing this to maths, which they described as having a well-structured content basis that informed the structure of lessons, technology didn't have a coherent structure. How could it? My participant reflected on how this is not problematic in technology. Stating how this was common practice, and something which out to be celebrated about the learning area. Despite my internal agreement, I decided to pick at the anecdote. I asked them:

How would you describe the content of technology?

On face value this is a very simplistic question. It is worthwhile reemphasising that this participant had discussed the nature of teaching and learning in technology education for almost an hour. Learning intentions, and the evolution of practice from year to year, different rationales for teaching technology, appropriate pedagogical approaches and broader subject philosophies had all be discussed, despite this, when posed with the question, the participant exhibited dismay.

I decided to use the anecdote above at the end of future interviews, and to conclude with this question, *how do you describe the content of technology education?* With each use, the question was met with similar levels of discomfort (and in a few instances, what appeared to be distain). where it was met with similar levels of discomfort (or distain). A selection of responses is presented below.

> "I would find it very difficult to, and you'd be waiting a couple of hours for a reply, if I'm honest."
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> "I think it's so broad. Like, it's so broad and it's so dynamic and so evolving all the time, because I guess like the word "technology"... even technology when you look at it on a wider platform, like internationally, like, it is so utterly changing."
>
> "Okay. Yeah, technology... it's huge. Yeah, I suppose... coming up with solutions to problems I suppose, isn't it?"; "It's life skills. It's, it's setting students up to the, um, you know, worthwhile citizens."
>
> "Our expectation is that they are going to become self-managing and that they are going to be independent, uh, risk takers. And like I'd also be inquiring, so they need to go and find out information about things."

> "The content is fluid. And it has to be."

Bordering on apologetic in asking this question, the more it was asked, the more it became apparent that we do not, as technology educators, think about content as a technical educator would have. This is not a critique of the participants in the study, quite the opposite, their expertise had been exhibited in their responses to prior questions. Instead, the question appeared to probe at an approach to thinking about teaching and learning that technology education was beyond. There was not table of contents for technology education.

The tension for participants appeared to focus on the overlap between technical education and technology education. Irrespective of the evolutions in policy and curriculum, the philosophical shift from vocational to holistic or general education, and the development of pedagogical approaches to facilitate such change, the remnants of technical education remain. By this, I mean the vocational contexts. Associated with each vocational context is a body of explicit content that, by comparison to the nature of technology education, is easy to explicate, organise, and easy to write as a table of contents. While the degree to which technical contexts influence policy and practices in different national contexts, their mere existence was sufficient to derail a discussion around the content of the technology education. As I asked this question over and over again to participants in different technical and national contexts for technology education I was reminded of Daker's subtitle for his 2014 book, *breaking with the past*, and the rather bleak view of attempts to incorporate technological literacy into extant technology education practices, stating "it cannot be done, it has not been done, it will not be done" (2014, p. 1). In existing efforts to breaking with the past, what role do the technical contexts play?

Is the content of technology education defined by a technical context?

In discussing the epistemological basis of technology education, the relevant content knowledge is often defined as that which is needed to progress learners thinking and action towards the resolution of a problem. The associated fluidity through which technological knowledge is conceived (de Vries, 2005; Williams & Lockley, 2012), is presented as indicative of authentic technological activity. This suggests that the

content of technology education is not defined by the technical contents, but rather elements of the technical context may be deemed relevant on an ad lib basis. If the knowledge associated with technical context is useful in navigating a problem, then this knowledge may be termed technological in nature. While this distinction has utility in demarcating the boundary between technological knowledge and other forms of knowledge, a challenge arises when this circumstantial knowledge is represented as the full extent of technological knowledge. The knowledge associated with navigating the problem at hand, whether prescribed or defined by the learner, should also be considered as relevant. As arguably, this is the *content* of technology that is common across technical contexts.

Commonality: The holistic nature of Technology

When asked to write this chapter, I took some time to reflect on the Marc's extensive contributions to my understanding of technology education. Several discussions, presentations, and publications come to mind, however, one stood out. Published in 2011 with Ammeret Rossouw and Michael Hacker, Concepts and contexts in engineering and technology education: an international and interdisciplinary Delphi study, presents an apparently simplistic model of technology education that is proposed as an instigator for curriculum development. The nuance of the model lies in the identification of technological concepts that transcend national and technical contexts. Within the 2011 article, technical contexts are presented as "relevant and meaningful contexts through which these concepts can be taught and learnt" (Rossouw et al., 2011, p. 409). In an effort to assist learners in understanding the relationship between technical contexts, unifying concepts were identified by participants in this Delphi study, and it was envisioned that the presentation of such concepts with give insight into the holistic nature of technology.

Table 1. Concept list for technology education (Rossouw et al. 2011)

Main concept	Sub-concepts
Designing (‘design as a verb’)	Optimising
	Trade-offs
	Specifications
	Invention
	Product lifecycle
Systems	Artefacts (‘design as a noun’)
	Structure
	Function
Modelling	
Resources	Materials
	Energy
	Information
Values	Sustainability
	Innovation
	Risk/failure
	Social interaction
	Technology assessment

In the same way that the convergence of different technical contexts appears to have resulted in challenges in articulating the content of technology education, vocational education was just one origin for technology education. There are multiple different approach found in practice today, for example, a craft-oriented approach; an industry-oriented approach; a science-oriented approach; a 'high-tech' approach; an engineering concepts approach; a key competencies approach; a design-oriented approach; or; a social issues approach (de Vries, 2000). In problematising these categorisations, de Vries (2000) noted that with increasing contact between academics internationally, the difference among the approaches found in various countries has gradually becomes less apparent than the categorisation above suggests. It is from this perspective, to support the synthesis of various aspects of technology education, that de Vries and colleagues later proposed a concepts-

contexts model for curriculum development (de Vries, 2011, 2014; Rossouw et al., 2011).

In proposing a concept-context approach, de Vries (2014) highlights the intention to confront learners with the same concepts in different contexts "so that they get to know the concept in a more in-depth and versatile way, and in order to embed the concept in a network of concepts that also provides insights into relations between concepts" (p. 335). The metaphor of a chameleon is used to emphasise the potential of the concept-context approach to facilitate conceptual learning. If a concept is only perceived in one context, in this case a chameleon in a grassy field, that would give the impression that chameleons are green. It is only once one has seen a green chameleon in a grass field, a blue chameleon near water and a grey chameleon one the pavement that the conceptual understanding of what a chameleon is can be reached. If a person does not grasp the concept of a chameleon "it is difficult to separate those characteristics that define a chameleon and those that are not essential for chameleons but context-bound" (de Vries, 2014, p. 331).

Can the content of technology education stand independent of technical contexts?

My doctoral research (Doyle, 2020) investigated teachers' conceptions of the purpose of teaching technology, through reflection on the enacted practice. Inspired by and congruent with the concept-context approach, both technical contexts and national contexts did not supersede technology education, as the intention was to understand teachers' conceptions of technology education, not materials, food, textiles, digital, etc. In the analysis, the role of technical context, stemming from anecdote described previously, and representations of content, referred to as subject matter, were lenses through which the goals of technology and progression within technology were investigated. Ultimately this analysis resulted in the presentation of three different conceptions of the purpose of teaching technology; (1) Obtain knowledge and skills for application, (2) Ability to act in a technological way, and (3) Ability to think in a technological way (Doyle et al., 2023). In the following sections, I will briefly discuss these different approaches to technology education relative to the concepts-context framework.

The first approach to technology education termed *obtaining knowledge and skills for application* adopted a sequential approach to skills development. The technical skills and knowledge that were held as

fundamentally important form the context and in turn content of the subject. Relative to the concept-context curriculum model, a singular context approach was adopted. This context provided the structure of technology education, and the concepts identified by Rossouw et al. (2011), while acknowledged, were not a significant focus.

The second approach identified held the *ability to act in a technological way* as the purpose for engaging with technology education. Within this approach, the applied concepts from Rossouw et al. (2011), designing, modelling and values, formed the primary content of technology education. The approach to technical contexts differed here, as in some instances a variety of technical contexts was sought, and in other, consistency of technical contexts was adopted. Importantly however, the technical contexts themselves were not represented as content, rather means to an end. The technological actions of designing, modelling, and making value-laden decisions was instead presented as the focus.

The third and final approach focused on learners developing the *ability to think in a technological way*. The primary distinction between the previous approach is that engagement with manual technological activity was no longer necessitated. Again, a variability of technical contexts was advocated within this approach, and interesting, the rationale for shifting technical context is to ultimately refocus on technological concepts (i.e. the content). The specific concepts from Rossouw et al. (2011) that appear central here were studying design, understanding systems, investigating resources and value-laden decision making.

In addition to the concepts identified by Roussow et al. (2011), a notable example of technological content that appears to stand independent of technical contexts is the increasing focus placed on the philosophy of technology. Presented as a focus on Nature of Technology (NoT), and drawing from relevant philosophical, historical and sociological literature, the intent of studying NoT is to provide a robust description of what technology is, how and why technology is developed, how technology and science impact each other, and how individuals and society direct, react to, and are at times unknowingly changed by technology (Clough et al., 2013; Pleasants et al., 2019). Recently, NoT has received attention within social studies education (Krutka et al., 2022). However, it can also be found in technology education curriculum, notably New Zealand (Ministry of Education, 2017), where NoT is presented as one of three stands of the curriculum, alongside technological knowledge and technological practice.

Indifference: Fluidity of technical context for technological concepts

In returning to the idea of content for technology education, the variability of technical contexts and what are deemed relevant technological concepts present an expansive, and ever-growing body of content for technology education. The approach of teaching concepts in multiple contexts is described by Rossouw et al. (2011, p.423) as a "middle road between total unbelief in the possibility of teaching and learning abstract concepts … and a naive belief in the possibility to teach such concepts directly at a high level of abstraction only to apply them later in various contexts". In tandem with a focus on specific concepts, this approach aligns with the everchanging needs of the 21st century. The adaptability association with familiarisation with and navigation of novel contexts has the potential to foster a mindset conducive to change.

Implicit within the concept-context approach is a shift away from a singular technical context for technology education. Again, this may be an uncomfortable thought for many – requiring a fundamental change in curriculum for many contexts. Despite this, the fragmented purposes for technology education discussed in the previous section suggest the need for conceptual coherence within technology education. I began this chapter by describing my background studying to be a Materials Technology (Wood) and Technical Graphics teacher. The strength that traditionally came from this position is that the subjects, and their content was well understood. While it is acknowledged that they may present a more reductive view of technology education, their place and status within curriculum holds. Similarly, while the weight of content associated with technical contexts most likely precludes engagement with broader concepts of technology education, their place and status within curriculum holds. By comparison, the decline of Design and Technology as a subject area in the English national context can be seen as a cautionary example. It illustrates how moving away from a technical focus, without a clear conceptual framework, can lead to the creation of a subject fraught with challenges. Although a multitude of factors have influenced the demise of technology education in this context, Spendlove (2022) highlights the lack of a clear understanding of what the subject is as a significant contributor.

And so, given the thirteen years since publication of the initial concepts-contexts paper, and the increasing collaborations, and understanding of technology educations internationally, I would like to ask Marc, how do you describe the content of technology education?

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