

Enhancing technology teachers' use of web-based resources: Using TPACK as a tool for communication and analysis

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Abstract

Technology education has unique resourcing needs, some of which can be conveniently and often more effectively met by web-based resources (WBRs) than by paper-based resources or even direct contact with communities of practice. However, despite the acknowledged potential of the Internet to transform education, and increasing access to, and use of, WBRs in schools, teachers are not necessarily well prepared to integrate them effectively into their pedagogy. This is not surprising given the range of specialised knowledge that effective integration requires – what Koehler and Mishra (2009) have called technological pedagogical content knowledge (TPACK).

The context for this paper is a research project in which seven experienced secondary technology teachers participated in a sustained professional development programme aimed at enhancing their integration of WBRs into their technology programmes. The study employed an interpretive research design and qualitative research methods, and was underpinned by sociocultural theoretical perspectives.

The focus of the paper is on how the TPACK framework was used as a tool to facilitate communication of theoretical ideas about effective integration of WBRs, and to analyse the teachers' developing knowledge as they tried out new approaches in the classroom.

Keywords: *Web-based resources, teacher professional development, pedagogical content knowledge, technological pedagogical content knowledge (TPACK)*

Introduction

The need to develop teachers' content knowledge and understanding of the nature of technology remains an issue for technology education. The interdisciplinary nature of technology education; the importance of teaching in relevant and authentic contexts; the individual project-based approach, particularly at senior secondary level; and the need to explore historical as well as contemporary technologies and innovations and to forge ongoing relationships with practising technologists, communities of practice and other stakeholders, all present considerable challenges to teachers for providing the breadth of knowledge students need to access in their technological practice as well as for expanding their own knowledge as teachers. Web-based resources (WBRs) have the potential to support teachers to effectively and conveniently contribute to many of these resourcing needs.

However, despite the acknowledged potential of ICT to transform education, generally this vision has not yet been realised (Bolstad et al., 2012; Lai & Pratt, 2007; Somekh, 2008). Despite heavy investment in resources and infrastructure to support the integration of ICT in schools, a large body of research describes predominantly low level uses and limited pedagogical change both internationally (e.g., Ertmer, 2005; Harris & Hofer, 2011; Harris, Mishra, & Koehler, 2009; Ho & Albion, 2010; Koehler & Mishra, 2008), and in New Zealand (2020 Communications Trust, 2011, 2014; Lai, 2008; Lai & Pratt, 2007; Wright, 2010).

Early approaches to ICT professional development were mostly generic and focused on how to use hardware and software with little concern for how needs and uses might vary in different subject domains and classroom contexts (Thompson & Mishra, 2007; Wallace, 2004). Too little attention was paid to the learning theories underpinning the use of technology in education (Lai,

2001). A significant body of research now highlights the importance of pedagogy and constructivist theories of learning in effecting transformative use of ICT and better meeting the needs of twenty first century learners (Albion & Ertmer, 2002; Lai, 2008; Lai & Pratt, 2007; Voogt, 2008, 2010). However, developing the knowledge and skills required to integrate new technologies in transformative ways is far from a straightforward process and many barriers continue to hinder the vision for effective use of ICT in the classroom.

Technological pedagogical content knowledge

Effective integration of ICT requires significant additions to teachers' knowledge base, and often requires a change in pedagogical reasoning (Baggott La Velle, McFarlane, & Brawn, 2003; Ertmer & Ottenbreit-Leftwich, 2010; Webb, 2005; Webb & Cox, 2004). The concept of Technological Pedagogical Content Knowledge (TPACK) (Koehler & Mishra, 2008, 2009; Mishra & Koehler, 2006) offers a useful framework for understanding and communicating the broad and complex knowledge base required by teachers for effective integration of WBRs.

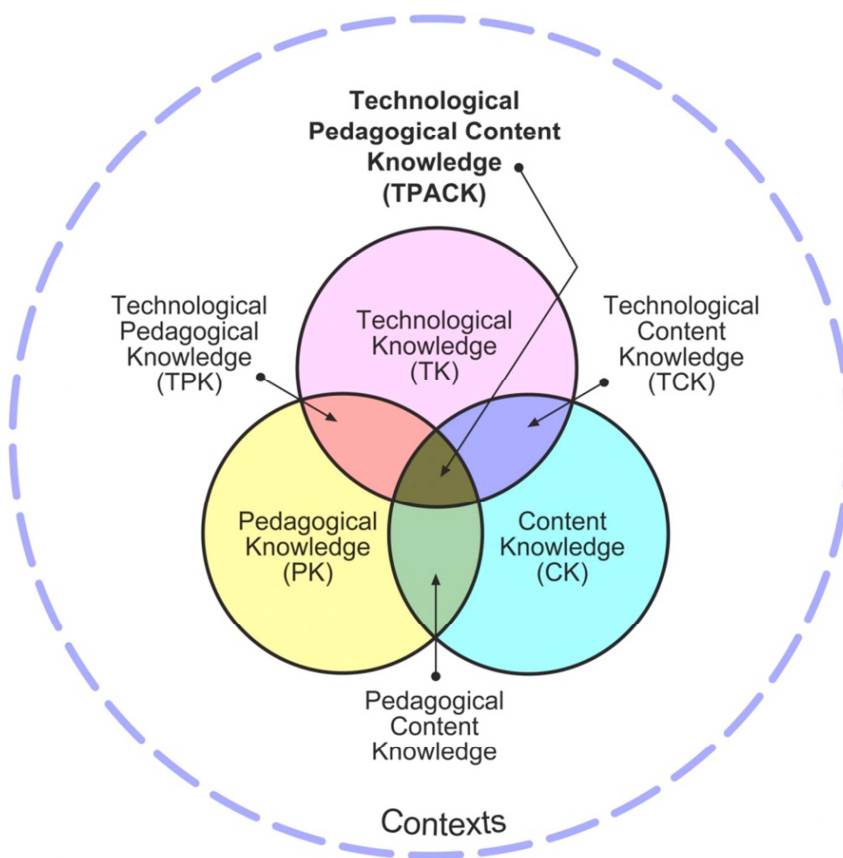


Figure 1 Technological pedagogical content knowledge. Reproduced with permission of the publisher, © 2012 by tpack.org

TPACK expands on Shulman's (1987) pedagogical content knowledge (PCK) construct to incorporate a third core knowledge component – *technological knowledge* (TK) (see Figure 1). TK in this construct refers to knowledge of ICTs and their use, and is distinct from technology education as a school subject. It is required, according to Mishra and Koehler (2006), and others, because the rapid expansion of digital technologies demands knowledge beyond what is defined in Shulman's construct. Adding TK to the construct introduces three new intersecting areas of teacher knowledge to PCK: *technological content knowledge* (TCK), *technological pedagogical*

knowledge (TPK) and *technological pedagogical content knowledge* (TPACK). As with PCK, the TPACK framework recognises the unique and integrated nature of content and pedagogical knowledge, the interdependence of each of the TPACK components, and also the critical influence of the individual classroom and school context on teacher actions (Harris et al., 2009).

Viewing the knowledge requirements for effective technology integration through a TPACK lens helps to shift the emphasis away from technocentric approaches, which focus on mastery of specific technology tools rather than their application to teaching and learning in a particular subject. Rather, it highlights the need for teachers to develop a nuanced understanding of the three sources of knowledge (technology, content and pedagogy) and their complex interrelationship (Mishra & Koehler, 2006).

Research design

The overarching research question guiding this investigation was: *How can teachers be effectively supported to enhance their classroom integration of WBRs in secondary technology education?*

The research involved the design and implementation of a sustained intervention programme to support participants to enhance their classroom integration of WBRs in technology education. The participants – seven experienced secondary technology teachers – were from three different schools, had a range of backgrounds, and taught a range of technological areas including food, textiles, and structural technology.

The study employed an interpretive methodology and qualitative research methods, and was underpinned by sociocultural theoretical perspectives. The design of the intervention encompassed general characteristics of effective professional development, ICT professional development and sociocultural theories of learning, and was influenced by Bell and Gilbert's (1994) model of teacher professional development emphasising the importance of addressing three dimensions of teacher development (personal, professional and social).

Table 1 *Research Phases 2011*

Research phase	Research methods used	Timing
1. Intervention design and group workshop	1. Initial individual semi-structured participant interviews to gather baseline data 2. Recording of interactive components of the workshop	Terms 1-2
2. Teacher planning and implementation of a unit of work using WBRs	1. Individual semi-structured participant interviews 2. Classroom observations 3. Collection of relevant planning documents	Terms 2-3
3. Evaluation	1. Final individual semi-structured participant interviews 2. Recording of interactive components of the evaluation workshop	Term 4

The research involved three phases (see Table 1). Phase one involved a one-day professional development workshop. Phase two was situated in the participants' individual schools where

they were expected to plan and implement a suitable unit of work with a focus on effective integration of WBRs and implement it in the classroom. The research concluded with a second group workshop (phase three) in which participants shared and evaluated their experiences using WBRs, the impact of these experiences on their beliefs about the value of using WBRs and the likely long-term impact on their practice.

The research employed a qualitative case study approach (Merriam, 1998). The main source of data was three sets of individual interviews at the beginning, middle, and end of the intervention programme (see Table 1). Data also included group workshop discussion, classroom observation, and analysis of teacher planning documents. Multiple methods provided a means of triangulating the data (Denzin & Lincoln, 2011).

TPACK as a communication tool

The TPACK framework was incorporated in the first workshop as a tool to help communicate new theoretical ideas and facilitate participants' learning about effective technology integration. TPACK provided a means of introducing theoretical ideas in a way that assisted teachers to make links between the new ideas and their existing knowledge and expertise (their PCK). In this way the framework helped to engage them in theory and effectively scaffold their professional learning (Bransford, Brown, & Cocking, 2000; Timperley, Wilson, Barrar, & Fung, 2008). Correspondingly, TPACK provided a means of acknowledging the participants' existing PCK helping them put into perspective the new knowledge required for effective integration of WBRs, and assisting them to view the problem of integrating WBRs as only one aspect of their practice rather than seeing their teaching overall as problematic. Acknowledging teachers' existing knowledge helped ensure that they perceived their participation in the intervention as learning rather than remedial – an important part of their professional development (Bell & Gilbert, 1994). It also appeared to give the participants a greater sense of agency to take control of their own learning, which was important for learning and change to be sustained beyond the workshop (Bell & Gilbert, 1994).

Gaining new teaching ideas was also an essential element of the teachers' professional development. Sharing examples of their classroom practice in the first workshop enabled the participants to gain insights into how other teachers were using WBRs to support learning of particular technological concepts. Collaborative analysis and linking of participants' classroom experiences with the components of TPACK helped them to consider how they might adapt their classroom practice using WBRs to better support student learning. These activities using the TPACK framework were designed to help shift participants' thinking beyond technocentric classroom approaches and scaffold subsequent planning to integrate WBRs into their own units of work.

Teachers' initial and developing TPACK – findings and discussion

As an analytical framework, TPACK provided a useful tool for evaluating teachers' existing knowledge and pedagogy using WBRs and for understanding how their pedagogy changed as they focused on enhancing their use of WBRs in their classroom. By way of example, the developing TPACK of two teachers from one participating school (School A) are presented in this paper.

Alison (a pseudonym) specialised in teaching Food Technology and was Head of Department (HOD). Ashley (a pseudonym) taught mainly Textiles Technology. These two teachers had contrasting levels of experience using WBRs, and views about the educational value of WBRs, yet both experienced a significant shift in their thinking as a result of participating in the research.

Although increasing teachers' ICT use was a priority in School A and the Principal was very supportive of the participants' involvement in the research, their access to ICT was limited.

Alison had neither computer access nor data projector in her classroom while Ashley had three computers and a shared data projector. Accessing computers for a whole class was difficult for both teachers.

Initial TPACK

At the start of the research Alison used WBRs in the classroom very occasionally, for student research or for showing YouTube videos of food processing methods. She was positive about the value of WBRs for engaging students, but had limited computer skills and lacked confidence. This is exemplified by her introduction at the first workshop where she commented: “I have a little dabble and then something happens and I run back to the tried and true method”. Her lack of TK reduced her confidence to use WBRs in the classroom. As a consequence she seldom used them and when she did her focus was mainly on managing the technology and students’ use of it (a technocentric approach). Her limited use of WBRs and her focus on managing the technology restricted her ability to develop TCK and TPK.

By contrast, Ashley had a wealth of computer experience. She had grown up with computers from a young age and had gained a lot of computer skills from previous secretarial experience. Ashley had also continued throughout her working life to be surrounded and influenced by people with a deep interest in, and experience with, computers. Consequently, Ashley was very comfortable and confident using WBRs – but rarely used them in her classroom. Ashley reported being very satisfied with her teaching using traditional resources, and didn’t feel the need to incorporate anything new such as WBRs. Further, she felt that adding anything else to her programme would compromise the practical component of the course and meeting assessment requirements.

Both participants had limited TPK at the start of the research. They lacked inherent awareness of the pedagogical affordances and constraints of WBRs and had not developed pedagogical strategies to maximise student learning when integrating WBRs in the classroom. In addition, Alison’s limited TK and focus on managing the technology meant little attention was given to any pedagogical strategies to scaffold student learning.

Alison’s initial TCK was very limited and appeared to be directly related to her lack of TK. Ashley, despite extensive computer experience and likely awareness of WBRs with relevance and value, held negative beliefs about the educational value of WBRs for technology education and appeared not to have considered the possibilities. Therefore, her TCK was also undeveloped.

Developing TPACK

Alison started trying out new ideas in the classroom very quickly after the first workshop using a school pod of computers on wheels (COW). Her first experiences were very positive, which boosted her confidence and she quickly reached a point where she no longer felt the need to master the technology before attempting to use it in the classroom. Rather, she became comfortable developing her own knowledge alongside her students. As she began to use WBRs more frequently, her TK (and confidence) developed more rapidly and she reached a point where her focus shifted from managing the technology to student learning. She was so inspired by the positive outcomes that she quickly extended her use of WBRs to all her classes. She began to view WBRs as just another (albeit very important) classroom resource to select from as and when appropriate for student learning. Importantly, she felt empowered to continue her own learning:

My enthusiasm and my growth is the big surprise, and just my hunger for wanting to keep it going. Yeah, I think it’s probably that I’m learning new stuff and it’s good to get into your learning while the kids are learning and you’re both travelling this road together. (Alison, interview 2)

By contrast, Ashley was relaxed about using computers in the classroom and confident that she could provide the support students needed and solve most problems that might arise. Her strong TK enabled her to be flexible in her approach and management of the class when using WBRs. For example, she could readily identify when students' lack of TK was impeding their learning and she was able to be responsive and provide spontaneous support.

During the research project, Ashley and Alison identified a range of pedagogical affordances and constraints of WBRs they had not previously considered – evidence of their developing TPK. For example, they identified WBRs as enabling a more student-centred pedagogy; offering increased potential to differentiate, enrich and extend student learning; and providing greater efficiency, convenience, currency and relevance to teaching and learning.

Planning for an explicit focus on integrating WBRs required them to think about pedagogical strategies to support student learning. As experienced teachers, their existing PK undoubtedly contributed to their ability to develop appropriate strategies for their individual classroom contexts. Rather than starting 'from scratch', as a beginning teacher would, they were able to integrate their existing PK with their developing TK. Building on and adapting familiar and tested strategies and reflecting on their previous success using these, they were able to more readily develop pedagogical strategies for working with WBRs, as the following comment suggests:

It really worked doing this – watch it, watch it and think about it, watch it and do it. I don't know why. I must have learnt that somewhere in the last seven years because I knew it. ... And yeah, it worked beautifully. (Ashley, interview 2)

Alison made significant progress in her development of TPK because of her extensive range of experiences using WBRs during the research, as well as her flexible access to computers and the Internet in her classroom, which she could use to supplement her use of the COW. Ashley only integrated WBRs in one unit of work, but her reflections also indicated significant development of TPK. It appeared that Ashley's strong TK may have been an advantage. She seemed to intrinsically understand and identify potential gaps in students' TK that could be barriers to their subject learning. For example, she reported:

There's a lot of learning about the how to, not content but how to. Not just using the equipment but what words to put in Google, you know, there's so many things. (Ashley, interview 3)

Ashley's level of TK also better enabled her to develop strategies to scaffold this aspect of her students' learning. In some cases she identified and prepared for this in her planning; at other times she identified gaps during a lesson and was able to intervene and provide spontaneous support. This explicit pedagogical focus on the students' lack of TK was much less noticeable with Alison.

Alison's developing TCK was evident as she took opportunities to use WBRs during the research. Her awareness of a range of WBRs with direct relevance to content she was teaching increased. She also increasingly recognised the affordances of WBRs for enhancing learning of content in particular ways. For example, Alison used Skype to collaborate with another school, and she noted the opportunities this offered for enriching students' learning:

Like, we went to that technology thing in xxx city earlier this year and their food places are just so much more user-friendly than ours, or whether we don't have the resources So it would be great to be able to Skype that guy who's doing the vanilla and talk about what he's doing, and be able to see the self-pollination and all that stuff and him talk about it. Whereas, when I talk about it, it's not the same. (Alison, interview 3)

While Ashley had limited experience using WBRs in the classroom, her well-developed TK and extensive experience using WBRs for her own purposes gave her a considerable advantage in developing TCK. She had a broad knowledge base to draw on as a starting point for developing TCK. For example, she was very aware of the extent and nature of resources that related to her subject area, and also had the skills and knowledge to source particular WBRs quickly. Implementing her unit of work, she soon noticed the affordances of WBRs for enhancing student learning. She reported broader and deeper learning by her students compared to using books or visiting a museum and noted how WBRs allowed students to take greater ownership of their learning.

The teachers' increasing TK, TPK and TCK contributed to their development of TPACK – the unique body of knowledge that emerges from the interaction and integration of all the individual components (Angeli & Valanides, 2009; Niess, 2011). Therefore, they had begun to broaden the knowledge base they could draw on in the pedagogical decisions they made to include the use of WBRs if and when they were deemed to best meet the needs of a particular learning situation.

Alison's developing TPACK was evident in the ability she demonstrated to flexibly and spontaneously appropriate WBRs in particular learning situations in the classroom. It was clear that using WBRs had now become an integral part of her teaching repertoire to the extent that she felt empowered to make a case to her Principal for improved access to computers for her department. Alison's experience during the research gave her the confidence and enabled her to provide evidence to support her case.

Although Ashley's experience was much less extensive than Alison's, it clearly prompted a shift in her thinking about the affordances of WBRs for her teaching. This shift was pivotal in inspiring her to consider how she could potentially integrate WBRs more broadly in her classroom programme. Her development in the components of TPACK and subsequently her ability and motivation to integrate this knowledge in her planning and teaching were clearly evident. In particular, her projections about her future use of WBRs, especially with increased access, were a clear indication that she considered them an integral resource in some teaching situations and suggested that her TPACK would continue to build.

Concluding remarks

The focus of the research was on how the intervention overall supported teachers to enhance their use of WBRs, the nature of change that occurred for each teacher and the key influential factors. The purpose of this paper was to describe how TPACK was used as one element of the intervention (as a communication tool, particularly during the two workshops), and to demonstrate its use as a framework for analysing the participating teachers' knowledge development as they integrated WBRs into their knowledge repertoire. The examples of the two teachers were offered as a snapshot of how their reflections were analysed and interpreted using a TPACK lens. It is suggested that at some point in the future, as emerging technologies become transparent and ubiquitous, the need for a separate framework (distinct from PCK) may diminish (Cox & Graham, 2009; Niess, 2011). However, in the current rapidly changing ICT landscape, using new technologies effectively in the classroom presents a significant challenge to teachers. TPACK provides a conceptual framework to support teachers to develop the broader knowledge base required to make informed and strategic pedagogical decisions about when, where and how using new and emerging technologies might enhance student learning in their subject.

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