TPACK as shared practice: Toward a research agenda

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Abstract: The task of using Information and Communication Technologies (ICT) to effectively teach hundreds of pre-service educators, many of whom never attend campus, is a significant challenge, which is amplified by the need to do so in ways that model how they might use ICT in their own classrooms once they graduate. This paper analyses a collection of posts written across a teaching year on a group blog by three teacher educators as they explored their practice and attempted to learn how to meet this challenge. The analysis uses a distributed view of knowledge and learning to identify the barriers and enablers encountered, and how the teacher educators developed their distributed TPACK throughout the year. The paper argues that a distributed view of TPACK offers some interesting insights that can inform practitioners, researchers and policy makers as they explore practice and learn how to meet the technology integration challenge.

Introduction

The 30+ year goal of effective integration of technology into learning and teaching remains elusive (Brantley-Dias & Ertmer, 2013) regardless of the voluminous amounts of effort, research, and literature devoted to developing insights into how to achieve it. Belland (2009) critiqued the focus of researchers on teachers' beliefs and barriers to adoption of Information and Communication Technologies (ICT) for learning and teaching. Instead he suggested that the explanation for limited uptake of ICT by teachers in their classroom practice is related to their past experience and its effect upon teachers' habitus or dispositions to act in certain ways. He argued that, consistent with the observation that teachers very often teach as they were taught, the most powerful influence on the practices of teacher graduates would be their own experience as students in school. He cited examples of teacher educators professing constructivist beliefs but using teacher-directed approaches to prepare teacher candidates to adopt constructivist practices. For teacher education to be effective in overwriting the effects of conventional schooling to graduate teachers prepared to integrate ICT it must employ the strategies it promotes and allow teacher candidates to experience them as learners. The value of such modeling has long been recognized (LeBaron & Bragg, 1994) but not often achieved.

Technological Pedagogical Content Knowledge (TPACK)–one recent significant component of the literature–has become a popular framework for describing the knowledge required by teachers to successfully integrate technology and has underpinned attempts to measure and develop the TPACK of individual teachers (Di Blas, Paolini, Sawaya, & Mishra, 2014). As a consequence of the on-going growth in the perceived importance of ICT in education it has increasingly been seen as essential for teachers at all levels of education to build their TPACK (Doyle & Reading, 2012). Hence, teacher educators require knowledge in the domains of content, pedagogy, technology and their various intersections. Typically they are well prepared by education and experience in content and pedagogy but technology, and its intersections with the other forms of knowledge, presents significant challenges. Teacher educators are subject to their own *habitus* (Belland, 2009) and often have limited, if any, experience of the application of new ICT. Lankshear, Snyder and Green (2000) observed that, where teachers have limited experience of particular practices in the real world, they are challenged to design related authentic activities for the classroom. The protean nature of ICT, as discussed below, continually places teacher educators in the position of needing to model ICT practices that are not established parts of their repertoire. How then can teacher

educators effectively model ICT integration so that the *habitus* of teacher candidates will be transformed? How can teacher educators develop the TPACK required for such modeling?

These were among the questions facing a group of teacher educators at the beginning of 2014. With a long history in the provision of distance education, the University of Southern Queensland has over recent years moved into online learning in a strategic way. The institution's strategic plan (USQ, 2012) seeks to "provide students with personalized adaptive learning support" through the use of "emerging technologies" that "enable collaborative teaching and individualized learning for students regardless of their location or lifestyle" (p. 6). For teacher educators this has meant that "by 2012, up to 70% of students in the 4-year Bachelor of Education were studying at least some subjects online" (Albion, 2014, p. 72) and struggling at times when the reality did not always match the institutional rhetoric.

Early in 2014 a private, shared blog was set up amongst a group of six teacher educators in an attempt to explore their shared practice and help bridge this reality/rhetoric gap. The blog provided a space to share stories about what frustrated, pleased, confused and surprised the teacher educators as they attempted to integrate technology into their teaching. Acting as a virtual water cooler, the blog evolved into a space where teacher educators at different stages of their careers could share practices; seek and provide support; and learn from each other.

Between February and October 2014, the six teacher educators shared a total of 82 posts and 150 comments, of which 77 posts (94%) and 111 comments (74%) were shared by three main contributors, who are the co-authors of this paper and, compared to other contributors, had higher levels of engagement with social media prior to initiation of the blog. All participants in the blog were invited to contribute to the paper but three declined for their own undeclared reasons on which we are unable to speculate. To avoid the complications of obtaining ethics approval and enlisting the other bloggers as research participants the analysis for this paper was restricted to the contributions of the co-authors who represented a range of experience and expertise. One teaches courses in ICT and Pedagogy and Networked and Global Learning with more than 20 years experience of university teaching and 3 years in teacher education. The second teaches courses in curriculum and pedagogy, rural and remote education, and teacher identity and professionalism and moved from school to teacher education 3 years ago. The third teaches courses in design and technology and online education and has more than 20 years experience in teacher education.

A focus on TPACK in the blog and the analysis for this paper was a natural consequence of the awareness of TPACK in Australian teacher education following a national Teaching Teachers for the Future project that used TPACK as its framework (Finger et al., 2013). One of the co-authors had been involved in that research and another teaches a course that explicitly seeks to develop the TPACK of teacher candidates making the focus on TPACK of teacher educators a natural extension. The same two co-authors have background in computing and a continuing interest in the potential for digital systems to be modified by their users acting as *digital renovators* (Jones, 2011).

Given the situated and distributed nature of the experience of using the shared blog, the paper draws upon a distributive view of learning and knowledge for this analysis. It begins by looking at recent writing around TPACK with a particular focus on perceived issues with TPACK and suggestions that a distributed view of TPACK might prove useful. Next, the paper describes four conceptual themes of a situated and distributed view of learning and knowledge. These themes are then used to identify and analyze the stories shared on the group blog. Finally, some initial questions for practitioners, teacher educators, researchers and policy makers are raised in the form of a proposed research agenda.

A distributive view of learning and knowledge

As noted by Di Blas et al. (2014), TPACK (the knowledge required to effectively integrate technology) "has consistently been conceptualized as being a form of knowledge that is resident in the heads of individual teachers" (p. 2457). The potential limitations of this perspective led those authors to draw on distributed cognition to explore the idea of distributed TPACK. Earlier, Putnam and Borko (2000) examined "new ideas about the nature of knowledge, thinking and learning" (p. 4), ideas which they labeled the "situative perspective" and included ideas such as situated cognition, distributed cognition and communities of practice. Phillips (2014) used these ideas in his investigation of the development and enactment of TPACK in workplace settings, implicitly recognizing the existence of TPACK as a form of shared practice embedded in context rather than knowledge held privately by individuals. Dron and Anderson (2014) suggest that the situative perspective of learning shares some common concepts and themes with a range of theoretical perspectives including heutagogy, distributed cognition, activity theory, Actor Network Theory, complexity theory and complex adaptive systems, Communities/Networks of Practice, and Connectivism. This range of perspectives has arisen from diverse disciplinary traditions.

Putnam and Borko (2000) developed three conceptual themes capturing the essence of these new ideas to examine the implications they may hold for how teachers design learning experiences, and learn about new ways of teaching. In the following we describe and use these three themes plus one other to analyze and draw implications from the stories shared on the blog.

Situated in particular physical and social contexts

The situated theme of learning and knowledge rejects the idea that context does not matter. Instead the entire context, understood as an interactive system including people, materials and representational systems, in which an activity takes place becomes "a fundamental part of what is learned" (Putnam & Borko, 2000, p. 4). The situated nature of learning means that an inappropriate context can limit transfer of learning into different contexts, a perspective that Putnam and Borko (2000) link to teacher complaints about professional development removed from the classroom being seen as "too removed from the day-to-day work of teaching to have a meaningful impact" (p. 6).

Social in nature

The social perspective of learning and knowing recognizes the important role of other individuals and of discourse communities beyond encouragement and stimulation. Instead, how we think and what we know arises from our on-going interactions with groups of people over time. The implication is that rather than learning being limited only to instruction in particular concepts and skills, it "is as much a matter of enculturation into a community's ways of thinking and dispositions" (Putnam & Borko, 2000, p. 5). The conception of schools as a powerful discourse community with established ways of thinking offers a partial explanation for the resistance to fundamental change of classroom teaching (Putnam & Borko, 2000).

Distributed across the individual, other persons and tools

The view of cognition as distributed proposes that the knowledge required to perform a task does not exist solely within an individual person, or just within groups of people. A distributed view sees cognition as requiring a contribution from a range of people and artifacts. The appropriate tools can enhance, transform and distribute cognition and through this expand "a system's capacity for innovation and invention" (Putnam & Borko, 2000, p. 10). This view offers lenses for exploring how technologies may be able to support and transform teaching and learning (Putnam & Borko, 2000).

Digital technologies are protean

Part of the argument for the addition of technology to Shulman's (1986) PCK (Pedagogical Content Knowledge) to form TPACK was that the rise of digital technologies had created "a very different context from earlier conceptualizations of teacher knowledge, in which technologies were standardized and relatively stable" (Mishra & Koehler, 2006, p. 1023). The rapid and on-going evolution of digital technologies means they never become transparent and it becomes important for teachers to continually develop technological knowledge (Mishra & Koehler, 2006). Though it has been suggested that, as digital technology use within schools becomes more common, "TPACK should, at least in theory, become embedded within other aspects of teachers' knowledge (Brantley-Dias & Ertmer, 2013, p. 117), the evolution of digital technologies will require corresponding changes in TPACK so that it is inherently unstable knowledge. With this theme we are seeking to explore two propositions. First, that technological knowledge should remain as a first class component of TPACK, for reason of its constant and rapid change. Second, that there may be benefits from changing the nature of the technological knowledge that is useful for teachers. As a result, this is a far more tentative theme than the previous three, but it also builds on the increased role technology plays in cognition suggested by those three themes.

Dron and Anderson (2014) quote Churchill (1943) as saying "We shape our buildings and afterwards our buildings shape us" (p. 50). But digital technologies are different, or at least they can be. Kay (1984) described the "protean nature of the computer" (p. 59) and suggested that it is "the first metamedium, and as such has degrees of freedom and expression never before encountered" (p. 59). However, experiencing the full protean nature of digital technologies requires the knowledge to manipulate them, particularly through (but not limited to) programming. If learning and knowledge are distributed across networks of people and objects – which in contemporary classrooms includes a significant proportion of digital technologies – then the ability to modify digital technologies appropriately would seem to be one approach to enhancing learning, especially given Shulman's (1987) view that

the distinguishing knowledge of a teacher is the capacity "to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students" (p. 15). With digital technologies it is possible and desirable that we shape our technologies, then our technologies shape us, and then – as we learn - we shape our technologies some more.

Stories from the blog

Analysis of the data from the blog posts and comments was undertaken using these four conceptual themes as the framework. The use of a priori codes rather than a grounded approach was justified by our interest in a distributed understanding of TPACK as described above. The posts and comments from the co-authors were gathered in a single document and examined for fragments that resonated with the themes. These fragments were marked and collected with annotations that were used to prepare the following analysis of the stories shared on the blog.

Situated

A number of discussions on the blog focused on the challenges of centralized processes or communications that needed to be contextualized to our own circumstances. As noted previously, an inappropriate context can limit transfer of learning, and posts from the blog demonstrated that a similar limitation was found when communications or processes seemed less than an effective fit for our context.

An indication that the institutional units responsible for the technologies at the university are perhaps not working in exactly the same context as teaching staff is revealed through upgrade and maintenance work occurring at perhaps the worst possible times. For example, upgrades to the online assignment submission and management system were scheduled in the week major assignments were due to be submitted.

Senior academics responsible for learning and teaching adopted a communiqué model to encourage effective learning, teaching, and technology integration. This involved periodically sending identical email messages to all academic staff across the university. Due to their less than context-specific nature, the communiqués were limited to largely generic information. The lack of connection to the situated experience of teaching staff became a common concern about this model. For example, a communiqué including notice of decommissioning of the old Computer Managed Assessment process was sent to all academic staff, regardless of whether they made use of this function.

When considering the importance of situated knowledge and understanding of ICT, questions were raised in terms of how we are preparing our students for their future teaching contexts. The institution's use of a Learning Management System (LMS) and other tools that are unlikely to be found in many schools generated questions about the usefulness of these approaches in terms of preparing students to transfer their experience and skills beyond the context of university into their own teaching practices. Further consideration of this notion can also be found below in relation to the 'distributed' theme.

Discussion on the blog noted, in particular, the power of our shared context as a strength of the learning opportunities afforded by the collaborative nature of the space. Centralized support options by their very nature have to be neutral and accessible by any academic within the many disciplines offered by the university, with the support on offer being limited to the experiences of staff typically without any knowledge of the specifics of teacher education. In comparison, a blog shared by a group of teacher educators enabled the sharing of expertise developed through many years in various education sectors and systems. Moreover, that experience was grounded in attempting to develop and harness TPACK to enhance teacher education to the same cohort of students, thereby significantly increasing the relevance of the support provided to our own needs and those of our students. This is reflective of two themes, firstly as mentioned previously that the learning opportunities within the blog were situated in our contexts, but also the notion that distributed TPACK is social in nature.

Social

By its very nature the blog was an appropriate way of sharing information in ways that fit into our own schedules, likely more so than a traditionally scheduled meeting or forum might have been. Furthermore, the approach provided opportunities for participants to post comments and observations, or voice frustrations, at the time that they arose. This resulted in a wider range of issues being raised than might have been discussed had we waited for a scheduled meeting. Issues or points that might not have ordinarily warranted a specific email or phone

call to other participants were quickly and easily posted to the blog. Fellow participants could then opt-in or -out of the conversation, depending on whether they were interested or experiencing a similar issue. Given that all three of us were comfortable in the interactive or social nature of online environments, the blog functioned well as a platform for discussion. That we contributed the majority of posts and comments on the blog does raise the question whether our colleagues found it an equally conducive platform.

One aspect of the blog that had significant rewards was the power of sharing practice, adding value to our teaching as a result. As a relative newcomer to tertiary teaching, Amanda was seeking to learn more about the ways colleagues were making use of the various functions afforded by Moodle, the LMS used by our institution. David provided access to the online environment for one of his courses, giving Amanda the opportunity to explore the ways of working initiated by a more experienced colleague who holds expertise in the field of ICT and education. One of the key themes explored earlier in this paper, the notion that TPACK is situated in particular physical and social contexts, was demonstrated by the blog in that it provided opportunities for learning that were contextualized to our field. This was particularly evident in the result of this collaboration, where Amanda was able to see the LMS being utilized in ways that she previously had not observed in other courses. In addition, this provided the opportunity to engage in informed discussions with David about the impact of certain tools and approaches being used in his course. An important aspect to note here is that this was provided in a context of teacher education courses as opposed to other, less contextualized, opportunities that may have been available through central support or elsewhere online. This resulted in a shift in practice for Amanda, adjustments to the online spaces, and more efficient ways of delivering learning experiences for students in her courses.

In the same vein, another significant discussion on the blog was about the delivery of course content and learning experiences for our students. Similar opportunities for shifts in practice resulted from discussions about processes for releasing course content, and even preferences for ways of recording lectures or vodcasts. The key opportunity here was the chance to discuss these approaches with people who had a shared context of teacher education, alongside the variety of levels of experience and expertise in different areas, which added a richness to the conversation. Interactions beyond the blog also benefited participants, with David and Peter's interactions in other online spaces such as Twitter providing solutions to challenges that David was facing with the LMS. The solution provided by Peter was identified as one that would not have been found as easily without these social networks.

Distributed

Stories from the blog are also illustrative of the notion that TPACK is distributed across the individual, other persons and tools. A number of the stories shared were identifying and sharing our responses to gaps in the complex assemblage of people, technologies and practices that make up learning and teaching, gaps that seemed to reduce the overall level of TPACK available across the system. One example of this problem was a new system for managing course documents that could support the use of only the Harvard referencing style, even though courses in teacher education and some other departments of the university courses require the use of the APA referencing style. Other examples of such gaps included issues with gaining access to computer labs, complexities of appointing casual teaching staff to work into courses, accessing the information necessary to create student groups, issues with the availability and performance of the LMS at the start of semester, and processes for contacting students who did not submit assignments, or checking in with students who had yet to engage within our courses. Discussion ranged from commiserating with our colleagues over having similar issues, to providing solutions which each of us had developed over time.

At times, though, these solutions became moot when systems changed unexpectedly and each of us identified some approaches that had worked in the past but were no longer possible for various reasons, either around submission of assessment, delivery and rollover of course content for ease of updating, or the continued use of an e-portfolio from a previous institution. While each of these issues was solved with workarounds, this was often a time sensitive exercise and the end result was not necessarily ideal. For example, Peter was working to modify course content from a previous semester and reached a solution, but "it took far longer than it needed to and finished in what seems an illogical arrangement".

The rise of Web 2.0 and the cloud has also seen a significant increase in the availability of a range of technologies (e.g., Google providing student email accounts) from providers outside of the institutional context. The use of Facebook and other social media as a means of working with students was also a pertinent discussion point at different times throughout the year. At times we discussed issues that had arisen on social media sites that were impacting upon the course (such as misinformation being disseminated and causing confusion for students), but we also discussed ways of trying to engage students on multiple platforms. Tensions sometimes emerged around this

integration of 'outside' technologies. One example of note is the frustration voiced by an institutional learning designer at the direction they were given to encourage the use of formally approved technologies only. The discovery of a taxonomy separating technologies into core, supported, allowed and emerging is also worth noting here and harks back to the concepts discussed earlier in the situated theme, wherein we questioned how comprehensively we were preparing students for a world beyond our institutional tools and approaches.

This insular, institutional view of allowed systems is the reason why the closing of discussion forums on course sites just prior to and for 72 hours after an exam is seen as a practice that will prevent students being able to communicate inappropriately about the examination. This seems to be a moot practice, given the standard experience of each course having its own (and sometimes multiple) student-created and private Facebook groups, not to mention the other LMS provided forms of communication that are available to students.

All of these experiences with the problematic distribution of TPACK across and beyond the institution are perhaps a significant contributor to an observation shared after a discussion with other colleagues, for whom "it was just accepted as par for the course that there would always be fairly major problems with the technology". This acceptance of problems not only contributes to frustration, it also raises questions about the impact on innovation. Amanda posed the question "it makes me wonder. How many people would put [innovation] in the too-hard basket and go back to a tried-and-true method that has worked for them before?". What impact does this have on the ability to effectively integrate technology, if the knowledge of how to effectively integrate technology is distributed across artifacts that are seen as always having fairly major problems? This leads directly to the next theme, which concerns the rapidly evolving nature of technology and the importance of being able to work with/in and around limited tools.

Protean

One solution to the problematic distribution of TPACK across complex assemblages is the idea of 'digital renovation'. Rather than accept these problems, digital renovation draws upon the protean nature of digital technologies to adjust or enhance rigid and problematic systems to develop solutions. Digital renovation provides the opportunity to open up new educational possibilities, but only for those with the TPACK to engage in digital renovation. For example, David shared a pedagogical practice during a planning day and generated some significant interest from another teacher educator. However, the digital technologies provided by the institution do not provide sufficient capability to make this practice plausible within the context of a largish course (300+ students). While David was able to write Perl scripts that bridged the gap, this particular renovation was very specifically situated within the context of the renovator and could not be easily adopted by others. So, despite the interest in an effective practice, it could not be adopted more widely.

But not all such solutions suffer the same problem. Throughout the year the shared blog was used to share and discuss tools and shortcuts that had been developed to work around (or within) the limitations of institutional systems, providing timely solutions for challenges that were, at times, plaguing all of us. The blog's enabling of timely solutions is vital here, ensuring that while teachers may be 'perpetual novices' (Mueller et al., 2008) when it comes to rapidly changing technology and tools, these solutions were developed and shared responsively, providing collegial support and breaking down silos that may have existed. The blog, therefore, enabled us to collectively grow our own solutions to issues as they arose.

The inability to undertake appropriate digital renovation also creates gaps at the institutional level. It has often been reported that a major problem for students using the university's LMS was their inability to find required resources within course sites. The widely accepted reason for this difficulty within the institution is claimed to be the inconsistent and poor layout and design of individual course sites. However, it also points to the apparent inability of the institution to provide an effective search engine - the widely accepted method for finding resources online - that works within the bounds of the institutional LMS. Interestingly, a project is currently underway to streamline course sites to provide a consistent environment for students and apparently solve the discoverability issue. Discussion on the blog raised questions about the impact of this that also relates to previous themes reflecting the importance of context and specialized knowledge – an environment that works in one course may not be a good fit for another.

A final conversation worth noting in relation to the concept that digital technologies are protean was about the complexities of working in a recently updated system and the subsequent requirement of teaching staff adopting new, and as yet untested, processes. The difficulties faced in adopting these practices raised the question of whether the digital fluency of teaching staff was sufficient. Another perspective on these difficulties arose from one participant noting that the systems and processes being used were 'scarcely fit for purpose', raising questions about the digital fluency of the institution. While it was clear that those involved had reasonable ideas about what makes for good online learning practice, they did not always seem to have the digital fluency required to translate those ideas into efficient and effective practice.

The blog afforded us an interactive, low-pressure space to explore these ways of improving our practice, to engage in thoughtful and critical discussions, and to share the load of developing these understandings.

Conclusions and a proposal for a research agenda

Throughout 2014 a group of six teacher educators used a group blog to share the ups and downs of trying to effectively integrate technology into the education of pre-service teachers. Analysis of the 77 posts and 111 comments shared by three of those teacher educators using a distributed view of learning and knowledge was used to extract insights into how these educators developed and shared the TPACK necessary to effectively integrate technology into their teaching. The analysis has revealed that our TPACK was enhanced through the ability to engage in social discussion with colleagues from within the same context. Such situated collaborations helped overcome the limitations of organizational practices and technologies that were not always well suited to our context and aims. Knowledge of how to leverage the protean nature of digital technologies to overcome some of these limitations also helped.

In this light and assuming that "developing TPACK ought to be a critical goal of teacher education" (Mishra & Koehler, 2006, p. 1046) what have we learned? We began with two questions enunciated in the introduction above. How can teacher educators effectively model ICT integration so that the *habitus* of teacher candidates will be transformed? How can teacher educators develop the TPACK required for such modeling? Although we cannot claim to have a complete answer we believe that there is evidence that our sharing positively impacted the TPACK of each of us. Coupled with the evidence from other studies (Di Blas et al., 2014; Phillips, 2014) this suggests that there would be value in encouraging teacher candidates to engage in similar sharing of their experiences with ICT. Our courses already promote such sharing but the evidence here has confirmed the value of such sharing and each of us will continue to share and to model that behavior for students in our courses.

As is frequently the case in research, our work revealed more questions than it answered. Table 1 provides a list of research questions that make up an initial agenda for future work that maps out some potentially interesting directions.

Table 1: Proposed research questions for future research on TPACK as shared practice

Themes	Research questions
Situated	• How will a University-wide consistent structure for course sites impact the situated nature of learning? • How can institutional learning and teaching support engage with the situated nature of TPACK and its development? • How can University-based systems and teaching practices be closer to, or better situated in, the teaching contexts experienced by pre-service educators?
Social	• How can the development of TPACK by teacher educators be made more social? • How can TPACK be shared with other teacher educators and their students?
Distributed	• Is it possible to measure the digital fluency of a university, rather than focus on its teaching staff? • How can technologies specific to teacher education (e.g. lesson and unit plan templates) be enhanced to increase the capability and learning of teacher educators?
Protean	• Can the outputs of digital renovation practices by individual staff be shared? • How can institutions encourage innovation through digital renovation? • What are the challenges and benefits involved in encouraging digital renovation?

In framing this research agenda, it is important to keep in mind that the distributed view of knowledge drawn upon in this paper strongly suggests that there are significant limits to what teacher educators can achieve alone. The knowledge required is situated, distributed and social. Thus the success of such a research agenda will depend on how effectively all of the people and artifacts involved in teacher education can be involved in this research agenda.

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