Editorial

TPACK – time to reboot?

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In this paper we explore and challenge the trajectory of research scholarship in the area of Technological, Pedagogical and Content Knowledge (TPACK). In doing so we adopt the position, as elaborated in Harris et al.'s (2017) editorial, that TPACK research is in need of addressing two key questions: What do teachers need to know in order to integrate technology effectively in the classroom and how can they best develop that knowledge? In order to explore this concern we undertook a review of research using the TPACK framework published in the *Australasian Journal of Educational Technology* over the last five years. The resulting 22 papers in which the TPACK framework was used substantially as a theoretical or methodological base for the research was analysed in regards to how TPACK scholarship is developing in relation to the research directions set out in the Harris et al.'s (2017) special edition editorial. The review concludes that much of the research identified focused on exploring, critiquing and validating the structure of the TPACK diagram and the seven components it describes. However, we argue that this focus has distracted researchers from addressing the key goals of TPACK and advancing understanding of effective teaching with technology. We conclude that there is a need for a fundamental shift in the trajectory of TPACK research, that is, to pay greater attention to understanding the knowledge that teachers need to use technology effectively for teaching and learning.

Keywords: TPACK, teacher education, technology

Introduction

Since its introduction in 2005, the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2005; Mishra & Koehler, 2006) has provided a rich foundation for research on the effective use of technology in teaching and learning (Kessler & Phillips, 2019). In a field that has been criticised as weak in its use of theory (Hew et al., 2019; Jones & Czerniewicz, 2011; Mishra & Koehler, 2006; Reimann et al., 2014; Warr, Mishra & Scragg, 2020), TPACK stands out as one of the few theories specific to educational technology research (Hew et al., 2019) and has been widely used in published research in relation to teacher education, teacher beliefs, classroom practice and program evaluation (Angeli et al., 2016; Voogt et al., 2013). While TPACK has proven a highly popular foundation for published research (Kessler & Phillips, 2019), a characteristic of TPACK research and scholarship has been the continued and lively critique of the framework, including in relation to defining and delineating the construct components, the relationships between construct components, measurement and validation, the predictive and prescriptive value of the framework and the relationship between TPACK and practice (Angeli et al., 2016). A number of researchers have systematically reviewed TPACK research or examined particular aspects of the TPACK framework, its theoretical underpinnings, measurement and validation and proposed agendas for future research work to improve the clarity and utility of the TPACK

framework and the impactfulness of TPACK research (Angeli & Valanides, 2009; Angeli et al., 2016; Brantley-Dias & Ertmer, 2013; Cavanagh & Koehler, 2013; Graham, 2011; Voogt et al., 2013).

In introducing the TPACK framework, Mishra and Koehler (2005; 2006) argued the need for a conceptual framework that describes "what teachers need to know in order to appropriately incorporate technology into their teaching" (Mishra & Koehler, 2006, p. 1018) and how this knowledge can best be developed in teacher education programs. Despite the sheer proliferation of published papers invoking TPACK and regular efforts to reset and refocus TPACK research, it is difficult to see substantial progress towards those goals.

Three years ago, this journal published what was believed to be the first ever TPACK-themed journal special issue. The editorial for that edition provided a historical summary of the development and use of the TPACK framework and described a challenging agenda for future TPACK research (Harris et al., 2017). The research agenda described in the editorial and explored in a number of the papers in the special edition, echoed those of other TPACK researchers and can be summarised in four parts:

(1) Improving our understanding of the measurement of TPACK and the validation of TPACK instruments;
(2) Better understanding how teachers and teacher education students develop TPACK;
(3) Better understanding how teachers and teacher students apply TPACK; and, finally,
(4) A focus on "cycles of teachers' knowing and doing", that is how teachers' TPACK knowledge is put into action in "reasoning, decision-making, and teaching processes" (Harris et al., 2017, p. vi).

The editorial noted the then approximately 1,200 publications that used TPACK as a foundation (Harris et al., 2017), a number that had swelled to 3,200 by 2019 as reported at an international conference on teacher education (Kessler & Phillips, 2019). In the last five years in this journal alone, TPACK has figured in a substantial way in 20 papers, including the seven in the special issue. Of the 20, four have had over a thousand downloads from the AJET site and eight have at least 20 citations recorded in Google Scholar. There is no doubt that TPACK continues to play a significant part in research in educational technology.

The impetus for this editorial came from discussions relating to the research work of one of the authors, who, with colleagues, had been exploring a new approach to understanding and describing teachers' TPACK by considering what it means to have more or less TPACK (Saubern et al., 2019, 2020). In those discussions, it was observed that despite the obvious influence of TPACK in the field of educational technology research and the energy and output of researchers using the TPACK framework, there was a lack of progress towards the original goals of TPACK, that is, understanding the knowledge that teachers need, and that pre-service teacher education students need to learn, to teach effectively with technology (Brantley-Dias & Ertmer, 2013; Graham, 2011). Reflecting on the contribution of the AJET TPACK publications and the continued impact of the AJET TPACK special edition, it was agreed to undertake a review of research using the TPACK framework published in the AJET over the last five years and reflect on how TPACK scholarship is developing in relation to the research directions set out in the Harris et al.'s (2017) special edition editorial and two key questions reflecting the original goals of TPACK: What do teachers need to know in order to integrate technology effectively in the classroom and how can they best develop that knowledge?

Method

The search terms "TPACK" and "TPCK" were entered into the search function of the AJET website. The resulting list of 44 papers was reduced to 22 papers by refining the search to papers published after 2015. A text search of the keywords, abstracts and article texts was undertaken to confirm that TPACK played a substantial role in each paper. Of the 22 papers, 20 included TPACK/TPCK as a keyword. On further examination, however, two of those papers did not use TPACK substantially as a theoretical or methodological base for the work, and were excluded. Two papers did not use TPACK/TPCK as a keyword but did use the framework substantially as part of the research and were included.

Each of the 20 remaining papers was read and the research problem, purpose and research questions identified and noted. The discussions and conclusions of each paper were considered and reviewed in the context of the four areas identified in the special edition editorial and the two key questions relating to the original goals of the TPACK framework.

Results and discussion

The 20 papers reviewed spanned a broad range of purposes, methods and contexts. Seven of the papers used a quantitative research method, ten used a qualitative method and two used a mixed method. Ten of the papers measured or directly observed TPACK using a published instrument or an instrument developed for the study. Five papers undertook some validation or structural analysis of TPACK measurement data. Fifteen papers were primarily focused on teacher education, mostly pre-service teacher education. Seven of the papers had a significant focus on examining the application of TPACK in practice. Eight of the papers had a specific teaching context focus (although some were quite broad, e.g. primary education, early years education).

A reading of the 20 papers reveals just how well the 'big idea' of TPACK holds up across a set of papers which have substantially different starting points, purposes, methods and contexts. The key TPACK insight, that to use technology effectively in teaching and learning, teachers must integrate knowledge of technology with knowledge of pedagogy and content, is a clear thread through almost all of the work. Supported by strong empirical evidence that teaching teachers technology skills in isolation does not lead to improved teaching and learning with technology (Angeli et al., 2016), this provides a strong theoretical frame and rationale for the work. This is exemplified by Niess and Gillow-Wiles (2017) when they write that just as pedagogical content knowledge (PCK) helped researchers understand that teachers merge their understanding of pedagogy and content to transform

> content into content meaningful for their students... In TPACK, teachers merge the three knowledge bases as they work to transform the content, as they know it, into content meaningful for their students while using technological learning tools. (p79)

However, at some point between the identification of this insight and the application of the TPACK framework in the research, something begins to shift. Rather than pursuing the idea of a specialist, integrated knowledge base, much of the application of the TPACK framework in the papers focuses on the separate parts of the framework, that is, some or all of the seven components: CK, TK, PK, PCK, TCK, TPK, TPCK. These components are measured, observed, compared to each other and other factors. Teacher education programs are evaluated by measuring the extent to which self-reports of the individual components increase. Scores on individual components are used to predict pre-service teacher education students' performance in practicums and to describe aspects of teacher education interventions. Undoubtedly, the papers contribute to our understanding of teacher education, the design of teacher professional learning, the use of technology in education and the TPACK theory and framework itself. However, few, if any, of the papers, investigate what it means for teachers to have and develop technological pedagogical content knowledge, this "emergent form of knowledge that goes beyond all three components" (Mishra & Koehler, 2006, p. 1028), and how this specialist knowledge relates to effective classroom practice. Amongst all this work, the central idea of TPACK, that in order to teach effectively with technology, teachers must develop a special kind of knowledge that is not technology knowledge but rather technological pedagogical content knowledge, seems to have slipped away. One of the papers, focused on investigating computational thinking (CT), does pose the question: "what does this unique body of knowledge (TPACK-CT) look like in practice?" but does not proceed to answer it (Mouza et al., 2017, p. 73).

In the 2017 AJET TPACK special edition, Harris et al. (2017) provide an excellent "brief history" of TPACK. Based on efforts to understand teachers' specialist knowledge in the 1980s and 1990s, in particular Shulman's (1986, 1987) idea of an integrated specialist knowledge base he called pedagogical content knowledge (PCK), it describes how researchers in the early 2000s began to focus on the effectiveness of teachers' technology integration and the specialist knowledge required. A number of researchers began building on the idea of PCK as the base knowledge into which technology knowledge must be integrated (Harris et al., 2017). Koehler and Mishra published a series of papers in which they developed their ideas and illustrated them with an evolving visual representation: a square, tetrahedron,

triangle, triangle with circles and then finally the familiar Venn diagram (Warr et al. 2020). In describing the framework in their 2006 paper, Mishra and Koehler first illustrated how two circles representing CK and PK combined to create PCK (figure 1) and then how adding a third circle, representing TK, created TPCK (figure 2), as well as the new intermediate components of TCK and TPK.

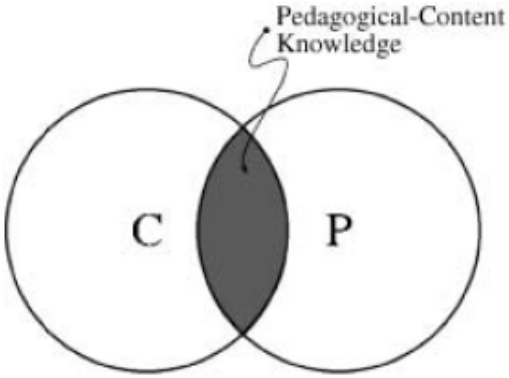

Figure 1: Pedagogical Content Knowledge as represented in Mishra and Koehler (2006)

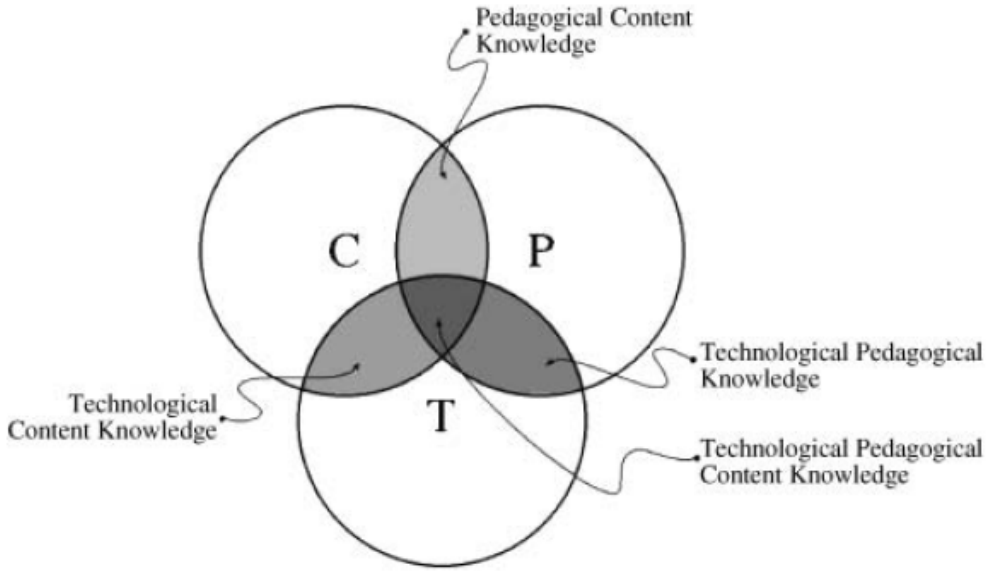

Figure 2: Technological Pedagogical Content Knowledge (TPACK) as represented in Mishra and Koehler (2006)

The particular choice of using a Venn diagram meant that the concept was illustrated visually in a certain way. The three overlapping circles of the Venn diagram representation created seven distinct regions (i.e. the seven TPACK components: TK, CK, PK, TCK, TPK, PCK, TPCK) which could be named, thought about and defined. While thinking about these components, in particular, the intermediate components TCK and TPK, pre-dates the publication of the final version of the framework diagram (Harris et al. 2017; Warr et al. 2020), the visual illustration of the TPACK concept using the Venn diagram cemented the component structure of TPACK. So, simultaneously, the publication of the TPACK framework established the ideas that TPACK is an emergent, specialist knowledge base, integrating teachers' knowledge of content, pedagogy and technology AND that TPACK is a construct made up of seven component knowledges and the relationships between them.

This editorial argues that it is this second way of thinking, encouraged by that "canonical image" (Mishra, 2019), the TPACK diagram, that is at the root of the problem that can be observed in reviews of the TPACK literature and the lack of progress towards the goals originally described for the TPACK framework. Specifically, while researchers seem to agree that what we are interested in is the way in which teachers integrate (and can be taught to integrate) their knowledge of technology so that technology use in teaching can be more effective, what they end up doing, encouraged by the TPACK framework diagram, is addressing the seven components *as if they were the thing that we were interested in*. So rather than research focusing on validating, evidencing and describing the core idea that for teachers to use technology effectively they must learn to integrate technology with knowledge of content and pedagogy (i.e. TPACK) rather than learn about technology separately (i.e. TK), much of the research focuses on the structure of the TPACK diagram and treats the seven components of the diagram as legitimate objects of study, which represent the TPACK idea and can be used usefully to analyse and understand teachers and teaching. This is particularly evident in the ongoing debate within TPACK scholarship on the transformational vs integrative nature of the TPACK construct (Angeli et al., 2016; Brantley-Dias & Ertmer, 2013; Voogt et al., 2013).

In reading the very detailed papers exploring TPACK via factor analysis, structural equation modelling, construct validity and epistemic network analysis, we were struck by how much effort was put into analysing and validating the structure of TPACK and its seven components as described in the diagram rather than focusing on the central idea of an emergent, integrated knowledge base. The same is true of evaluations of proposed teacher education programs. Many started with the core TPACK idea and then produced a research method to investigate how the program increased teacher pre-service students' CK, TK, PK, PCK, TPK or TCK. One paper read in this review seemed to suggest that a way to improve pre-service teacher education students' TPACK was to teach them the definitions of the TPACK components. Very few consider more holistically how the program helped teachers use technology more effectively to achieve teaching and learning goals. It is almost as if the TPACK framework diagram is so powerful that it obscures the very concept that it illustrates, and therefore researchers cannot see the TPACK wood for the trees.

Warr, Mishra and Scragg (2020) describe the interesting and dramatic path that Mishra and Koehler took from their original 'square' representations to the final familiar version of the diagram. But perhaps it could have been different. What if instead of illustrating TPACK with three overlapping circles, Koehler and Mishra had done it with two circles, representing the integration of technology knowledge into the single construct of teachers' pedagogical content knowledge (see Figure 3)? Or what if they had chosen an entirely different visual representation or no visual representation at all? Might this have allowed researchers to focus more on the core insight of TPACK, allowing them to concentrate on the difference between technological knowledge and TPACK and less on validating the "hidden complexity" (Graham, 2011, p.1955) of the TPACK diagram?

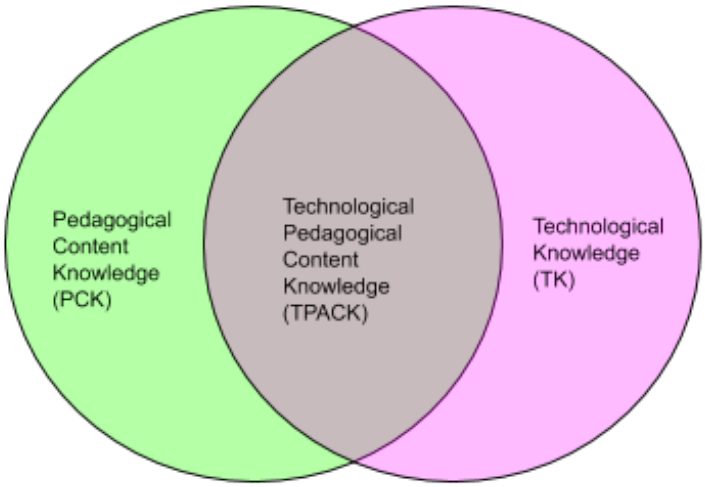

Figure 3: TPACK as the intersection of PCK and TK.

Conclusion

After 15 years and more than 3000 published papers (Kessler & Phillips, 2019), it seems we still know very little about what TPACK is in the sense of Niess and Gillow-Wiles (2017): Teachers' knowledge of how "to transform the content, as they know it, into content meaningful for their students while using technological learning tools." (p.79) The questions of how to measure TPACK, how to teach it, how to use it to make teaching with technology effective, that is, the research agenda identified in Harris et al.'s (2017) AJET TPACK special edition editorial, are critical. But what are we measuring, teaching and putting into practice?

This editorial argues for a reset in TPACK research. Rather than proposing a list of research directions, we advocate a fundamental refocusing of TPACK research. Echoing Brantley-Dias and Ertmer (2013), we argue that all TPACK research should have one fundamental purpose: to understand the knowledge that teachers need to use technology effectively for teaching and learning. The TPACK theory argues that it is not knowledge of technology itself which is the basis of effective teaching and learning with technology but rather a specialist form of knowledge which arises when knowledge of technology is integrated with pedagogical knowledge and content knowledge. Understanding this specialist form of knowledge means being able to describe it, not as a collection of other kinds of knowledge or in generic terms but rather in detailed "descriptions of the successively more sophisticated ways of thinking … that can follow one another" (National Research Council, 2007, p. 219). What do beginners understand? What do teachers understand as they become more knowledgeable in TPACK? What distinguishes experts from the merely competent? What does this look like in teaching mathematics, science, languages, art and design? Understanding TPACK also requires understanding how to measure it and how best to develop it in pre-service teacher education students and in-service teacher professional development. Tools that measure TPACK should be validated primarily in relation to the extent to which they represent the knowledge required to use technology effectively for teaching and learning rather than their fidelity to the TPACK diagram. Similarly, in using TPACK to inform the design of teacher education programs or evaluate their effectiveness, the focus should be on how TPACK helps us understand how to develop the capacity of teachers and pre-service teacher education students to use technology effectively in their teaching.

In presenting the TPACK model, Mishra and Koehler (2006) sought to draw our attention to understanding what teachers need to know in order to teach effectively with technology, how teacher education students can develop this knowledge and how developing and applying this knowledge leads to better learning outcomes for students. Given the popularity of TPACK in teacher education and education technology research, our expectation is that the next five years of AJET will see at least as many papers using TPACK as a foundation as the last five years. Our hope, and challenge, is that researchers will engage with the critical question which TPACK may provide insight: how best to improve teaching and learning with technology?

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Appendix: List of AJET papers reviewed

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