Chapter 20
The Impact of ICT on Pedagogical Practices in an Interdisciplinary Approach

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Abstract Technological, pedagogical and content knowledge (TPACK) is a growing area of research that describes the knowledge base required by teachers to proficiently use educational technologies. However, few studies have focused on TPACK in an interdisciplinary approach. This paper reviews the literature related to interdisciplinary approaches in school contexts and outlines the differing views of TPACK. A conceptual framework using ICT-PCK based on Angeli and Valanides (2009) conceptualisation of ICT-TPCK as a distinct body of knowledge is proposed.

Keywords Interdisciplinary • ICT • Pedagogical practices • TPACK

20.1 Introduction

Empirical research into the underpinnings of technological, pedagogical and content knowledge (TPACK) is still in the early stages, and a review of the literature by Voogt et al. (2013a) found that it is a complex concept that can be understood in differing ways. In the literature, the acronyms TPACK and TPCK are used, and this paper takes a similar approach to Voogt et al. (2013a) by using the TPACK or TPCK acronyms according to the research article's terminology. Most TPACK literature considers it as stemming from Shulman's (1986) concept of pedagogical content knowledge (PCK) (e.g. Abbitt 2011; Graham 2011; Voogt et al. 2013a). Nonetheless, Voogt et al. (2013a) argue the literature points to three views: as an extension of PCK (Cox and Graham 2009; Niess 2005), as the interplay between pedagogy, content and technology and the intersections of these three domains (Mishra and Koehler 2006) or as a body of knowledge that is distinct (Angeli and Valanides 2009). Much of the research using the TPACK framework focuses on single disciplines such as science and mathematics, and there has been little research into how information and communication technology (ICT) is impacting on teacher pedagogical practices in an interdisciplinary approach. In recent years there has been an interest in

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interdisciplinary curriculum models by teachers and policymakers at secondary school level, as a way of preparing students to be flexible thinkers, who can approach new problems from multiple perspectives by connecting different fields of knowledge (Boix-Mansilla 2010; CDC-HKEAA 2014). This paper will firstly outline the research questions for the current study exploring the impact of ICT in an interdisciplinary approach, then review the key concepts of interdisciplinary and TPACK in the literature and finally outline the conceptual framework.

The focus of the study is the impact of ICT on teachers' pedagogical practices in an interdisciplinary unit of study, and accordingly, two broad research questions emerge:

- How do teachers approach teaching an interdisciplinary unit of study?
- In what ways are teachers using ICT in an interdisciplinary unit of study?

The first research question explores teachers' understanding of the term interdisciplinary, the pedagogical practices they intend to use and the reasons for choosing these pedagogical practices in an interdisciplinary unit of study. Secondary school teachers generally operate in a discrete disciplinary structure, and this question investigates teachers' understanding of interdisciplinary approaches along with their educational beliefs and experiences. The second research question centres on ICT in an interdisciplinary unit of study by exploring how and why ICT pedagogical practices are employed in the unit of study. This is because ICT pedagogical practices may be aligned to the requirements of particular disciplines. Therefore, teachers' ICT competence and confidence may not necessarily transmit to the pedagogical practices required using an interdisciplinary approach, and they may be required to develop their ICT pedagogical practices.

20.2 Literature Review

20.2.1 Why an Interdisciplinary Approach?

Secondary school curricula are often organised with a timetable of discrete disciplines. A discipline is not solely the content area or facts used to form the subject knowledge (Moss et al. 2008; Nissani 1995). Each discipline potentially has a different set of learning tools, as well as exploring different subject matter or phenomena (Beane 1995; Moss et al. 2008). Curricula with interdisciplinary elements include Liberal Studies in Hong Kong (CDC-HKEAA 2014) and the International Baccalaureate Middle Years Programme (MYP) (Boix-Mansilla 2010). However, interdisciplinary approaches have been explored by educationalists for many years, e.g. Hopkins (1937) (as cited in Beane 1997), Jacobs (1989) and Tchudi and Lafer (1996). An interdisciplinary approach integrates knowledge from across multiple disciplines (Hammond and McCallum 2009). Similarly, Nissani (1995) suggests a working definition of an interdisciplinary curriculum as bringing together two or more distinctive disciplines.

Although it is acknowledged that a single-subject curriculum can also offer opportunities to undertake authentic real-world problems (Brown 2008), interdisciplinary learning has been advocated as a way of making connections between disciplines (e.g. Boix-Mansilla 2010; Brown 2008). Empirical research from primary and secondary school contexts offers evidence that interdisciplinary approaches can contribute to helping students make connections across disciplines and real-life situations (Rennie et al. 2011; Venville et al. 2000; Zhbanova et al. 2010). Students can also engage in issues that are relevant and motivating (Beane 1997; Brown 2008) and more closely matches the way people approach problems outside of the classroom (Griffin et al. 2012). Consequently interdisciplinary approaches may offer opportunities for students to develop their ability to transfer knowledge and skills into other contexts in order to prepare students to develop the capabilities required by knowledge societies. Venville et al. (2000) argue that a key issue for interdisciplinary approaches is that teachers may feel less confident about advising students about the subject knowledge they are less familiar with and question their own ability to teach in this way.

20.2.2 Differing Views of TPCK

TPACK is a conceptual framework to describe the knowledge base that teachers require to proficiently use technology and involves an alignment of the pedagogy, content and technology knowledge (Voogt et al. 2013a). The number of peer-reviewed papers on the ERIC database that have TPACK or TPCK in either the title and/or abstract on the 10th November 2013 was 104. Many of these papers focused on approaches to teaching that included in-service and pre-service professional development, beliefs and attitudes. The disciplinary orientation of nearly a third of the studies was on mathematics and science, with a few examples of interdisciplinary approaches in mathematics, science and social sciences.

Mishra and Koehler's (2006) TPCK framework has been widely used to consider teachers' knowledge and use of educational technologies (Voogt et al. 2013b). The initial series of papers by Koehler and Mishra (2005) and Mishra and Koehler (2006) referred to TPCK rather than TPACK. In 2007 Thompson and Mishra (2007) published an editorial paper announcing the change from TPCK to TPACK as it both emphasises the three types of knowledge they believe to be essential to technology integration and also the integrated nature of these domains. Other similar terms used in the literature are ICT-TPCK as a strand of TPCK (Angeli and Valanides 2009) and technology-enhanced PCK or TPCK (Niess 2005).

Voogt et al. (2013a) found that all 55 papers in their data set agreed that TPACK originated from Shulman's (1986) concept of PCK. Stevens et al. (2005) explain that Shulman argued that "research on teaching had focused on the wrong target" (p. 113) by not focusing on how teachers think about the interaction of pedagogy and content knowledge. PCK is considered an important feature of teaching as it involves integrating domain knowledge with appropriate pedagogical approaches so

that students can understand the subject matter (Voogt et al. 2013a). From reviewing TPACK literature, Voogt et al. (2013a) argue that there are three different understandings: (1) TPCK as an extension of PCK (Cox and Graham 2009; Niess 2005), (2) TPCK as a development of the understandings of the three domains of content, pedagogy and technology knowledge and the interplay between them (Mishra and Koehler 2006) and (3) ICT-TPCK as a distinct body of a knowledge (Angeli and Valanides 2009). Each of these perspectives will now be looked at in turn.

One view of TPCK is technology-enhanced PCK (Niess 2005). In her case study research with five pre-service science and mathematics teachers, Niess (2005) explains that TPCK requires a consideration of multiple domains of knowledge, and she suggests that courses to prepare student teachers need to consider how to guide pre-service teachers in expanding their understanding of the interactions between the knowledge of their subject area and their knowledge of technology (Niess 2005). Abbitt (2011) describes TPACK as a response to the growth in using educational technologies by integrating technology into Shulman's (1986) concept of pedagogical content knowledge (PCK). He remarks that both Niess (2005) and Mishra and Koehler (2006) emphasise the interplay between technology and PCK. However, Mishra and Koehler (2006) include technology knowledge as a third domain more explicitly along with pedagogical knowledge and content knowledge (Abbitt 2011). In their conceptual analysis, Cox and Graham (2009) claim that PCK has always included technologies and that, as digital technologies become ubiquitous, TPACK transforms into PCK. Cox and Graham (2009) argue that TPACK is extended as new technologies emerge.

TPCK as a development of understanding in all three domains is a second view of TPCK presented by Koehler and Mishra (2005) and Mishra and Koehler (2006). This necessitates that the teacher looks further than technical aspects and considers the importance of the interplay of technology knowledge, pedagogical knowledge and content knowledge (Mishra et al. 2009). Mishra and Koehler (2006) claim that: "Quality teaching requires developing nuanced understanding of the complex relationships between technology, content, and pedagogy, and using this understanding to develop appropriate context specific strategies and representations" (p. 1029). Voogt et al. (2013a) argue that Mishra and Koehler (2006) present TPCK as a development of understanding in the three domains and their intersections, whereas Niess (2005) views TPCK as an enhancement of PCK. However, these authors point out that researchers have found that the seven knowledge domains as conceptualised by Mishra and Koehler are problematic because it is difficult to agree of what are examples of each construct, e.g. Archambault and Barnett (2010) and Cox and Graham (2009).

Angeli and Valanides (2005, 2009) present a third view of TPCK, as ICT-related PCK (2005) and ICT-TPCK (2009), which they describe as a unique body of knowledge. Their research into pre-service teacher preparation found ICT preparation focused on technical understanding of various software applications rather than how to teach with ICT (Angeli and Valanides 2005). After mapping two ICT-enhanced design tasks, Angeli and Valanides (2009) found that pre-service primary teachers' ICT-TPCK competency improved over the course of a semester. Voogt et al. (2013a)

support the view that TPACK should be seen as a distinct body of knowledge, and they are surprised that few studies in their review discussed the meaning of TPACK for specific subject areas. They see TPACK as distinct from technology integration and a knowledge base where content needs to be considered (Voogt et al. 2013a).

20.3 The Conceptual Framework for the Study

The present study proposes to view TPACK as a distinct body of knowledge within the context of teachers' overall pedagogical practices in an interdisciplinary unit of study, with these practices informed by the teachers' characteristics and ICT knowledge (Fig. 20.1). Beliefs about technology and pedagogy are closely intertwined (Voogt et al. 2013a). Therefore, the conceptual framework will look at teacher characteristics and ICT knowledge in terms of their educational values and beliefs, ICT skills and beliefs as well as previous interdisciplinary experience. The top section of the conceptual framework shows a two-way process

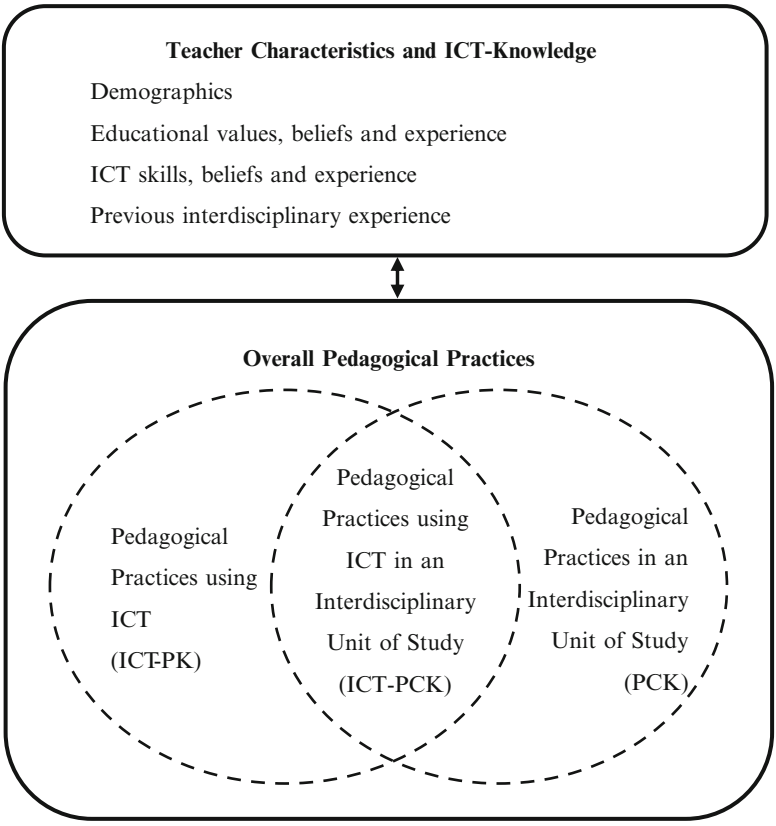

Fig. 20.1 Diagrammatic representation of the conceptual framework

between teachers' beliefs, values, experiences and ICT knowledge that will have helped shape their pedagogical practices.

The lower section of the conceptual framework covers teachers' overall pedagogical practices, which are informed by teacher characteristics and ICT knowledge. Overall pedagogical practices encompasses: the pedagogical practices used in an interdisciplinary unit (PCK), the pedagogical practices using ICT (PK-ICT) and the intersection of these, where ICT-PCK are the pedagogical practices using ICT in an interdisciplinary unit. PK-ICT are the skills and competencies teachers have developed for approaches using ICT in the disciplines they teach. PCK includes the approaches the teachers intend to use to cover content, skills and concepts to assist students make interdisciplinary links. ICT-PCK is conceptualised as a body knowledge within the context of teachers' overall pedagogical practices which has been constructed from PK-ICT and PCK when engaged in an interdisciplinary approach. The term ICT-PCK is used which is a variation of Angeli and Valanides (2009) conceptualization ICT-TPCK being a strand of TPCK, which is restricted to ICT. The research will focus on pedagogical practices and ICT, and so the construct will be referred to as ICT-PCK because this more accurately describes the focus of the study as it is investigating ICT as opposed to technology more generally.

Conclusion

Although interdisciplinary approaches have been advocated and investigated for a number of years, there is little research into the impact of ICT and interdisciplinary approaches in secondary schools. Frequently, TPACK research has been carried out looking at particular disciplines such as mathematics and science. The interaction between teachers' pedagogical practices and their characteristics and ICT knowledge is indicated on the conceptual framework for the present study. The conceptual framework uses the term ICT-PCK in an interdisciplinary approach, where ICT-PCK is viewed as a distinct body of knowledge within teachers' overall pedagogical practices constructed from PK-ICT and PCK. The research questions are intended to reveal how ICT is impacting on the pedagogical practices in an interdisciplinary approach both theoretically by investigating the concept of ICT-PCK and practically in terms of facilitating factors, as well as issues and concerns that may arise.

References

Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education, 43*(4), 281–300.

Angeli, C., & Valanides, N. (2005). Preservice elementary teachers as information and communication technology designers: An instructional systems design model based on an expanded view of pedagogical content knowledge. *Journal of Computer Assisted Learning, 21*(4), 292–302.

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education, 52*(1), 154–168.

Archambault, L. M., & Barnett, J. H. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers & Education, 55*(4), 1656–1662.

Beane, J. A. (1995). Curriculum integration and the disciplines of knowledge. *The Phi Delta Kappan, 76*(8), 616–622.

Beane, J. A. (1997). *Curriculum integration: Designing the core of democratic education*. Williston: Teachers College Press.

Boix-Mansilla, V. (2010). *MYP guide to interdisciplinary teaching and learning*. Retrieved May 22, 2012, from http://occ.ibo.org/ibis/documents/myp/m_g_mypxx_mon_1005_1_e.pdf

Brown, S. W. (2008). Assessment is not a dirty word. In D. M. Moss, A. Osborn, & D. Kaufman (Eds.), *Interdisciplinary education in the age of assessment*. New York: Routledge.

CDC-HKEAA. (2014). *Liberal studies curriculum and assessment guide* (Secondary 4–6, pp. 1–232). Retrieved May 7, 2014, from http://334.edb.hkedcity.net/doc/eng/curriculum/LS%20C&A%20Guide_updated_e.pdf

Cox, S., & Graham, C. R. (2009). Diagramming TPACK in practice: Using an elaborated model of the TPACK framework to analyze and depict teacher knowledge. *TechTrends: Linking Research & Practice to Improve Learning, 53*(5), 60–69.

Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Computers & Education, 57*(3), 1953–1960.

Griffin, P., Care, E., & McGaw, B. (2012). The changing role of education and schools. In P. Griffin, B. McGaw, & E. Care (Eds.), *Assessment and teaching of 21st century skills* (pp. 1–15). Dordrecht: Springer.

Hammond, C., & McCallum, F. (2009). Interdisciplinary: Bridging the university and field of practice divide. *Australian Journal of Teacher Education, 34*(2), 50–63.

Jacobs, H. H. (1989). The growing need for interdisciplinary curriculum content. In H. H. Jacobs (Ed.), *Interdisciplinary curriculum: Design and implementation* (p. 97). Alexandria: Association for Supervision and Curriculum Development.

Koehler, M., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research, 32*(2), 131–152.

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Mishra, P., Koehler, M., & Kereluik, K. (2009). The song remains the same: Looking back to the future of educational technology. *TechTrends: Linking Research & Practice to Improve Learning, 53*(5), 48–53.

Moss, D. M., Osborn, T. A., & Kaufman, D. (Eds.). (2008). *Interdisciplinary education in the age of assessment*. New York: Routledge.

Niess, M. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education, 21*(5), 509–523.

Nissani, M. (1995). Fruits, salads, and smoothies: A working definition of interdisciplinary. *The Journal of Educational Thought, 29*(2), 121–128.

Rennie, L. J., Venville, G., & Wallace, J. (2011). Learning science in an integrated classroom: Finding balance through theoretical triangulation. *Journal of Curriculum Studies, 43*(2), 139–162.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Stevens, R., Wineburg, S., Herrenkohl, L. R., & Bell, P. (2005). Comparative understanding of school subjects: Past, present, and future. *Review of Educational Research, 75*(2), 125–157.

Tchudi, S., & Lafer, S. (1996). *The interdisciplinary teacher's handbook: Integrated teaching across the curriculum*. Portsmouth: Boynton/Cook Publishers.

Thompson, A., & Mishra, P. (2007). Breaking news: TPCK becomes TPACK! *Journal of Computing in Teacher Education, 24*(2), 38/64.

Venville, G., Wallace, J., Rennie, L., & Malone, J. (2000). Bridging the boundaries of compartmentalised knowledge: Student learning in an integrated environment. *Research in Science and Technological Education, 18*(1), 23–35.

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013a). Technological pedagogical content knowledge – A review of the literature. *Journal of Computer Assisted Learning, 29*(2), 109–121.

Voogt, J., Knezek, G., Cox, M., Knezek, D., & ten Brummelhuis, A. (2013b). Under which conditions does ICT have a positive effect on teaching and learning? A Call to Action. *Journal of Computer Assisted Learning, 29*(1), 4–14.

Zhbanova, K., Rule, A., Montgomery, S., & Nielsen, L. (2010). Defining the difference: Comparing integrated and traditional single-subject lessons. *Early Childhood Education Journal, 38*(4), 251–258.