An International Investigation of TPACK

Petrea Redmond
School of Teacher Education and Early Childhood
University of Southern Queensland, Australia
redmond@usq.edu.au

Yehuda Peled
Western Galilee College, Israel
yehudap@wgalil.ac.il

Abstract: Effective technology integration requires knowledge and skills of three key interdependent knowledge areas: pedagogical content knowledge, technology content knowledge and technological pedagogical knowledge. At the intersection of all these knowledge areas is Technological Pedagogical and Content Knowledge or TPACK. From the analysis of the data from an online survey completed by pre-service teachers in Australia and Israel, the authors will share similarities and differences of TPACK across two international universities. The aim of this research was to identify if there are any contextual differences between the levels of TPACK in pre-service teachers from the two different countries.

This paper presents implications for teacher education programs that may be relevant in multiple contexts. The following are outcomes of the research. First, pre-service teachers are provided with a wealth of experiences using technology in their learning and in designing learning experiences in their course work. Second, pre-service teachers need to have opportunities to apply the theory of TPACK in the design of their lessons and learning tasks in their professional experience. Third, pre-service teachers have low confidence in TK and TPK. Finally, there is limited difference in the experience and confidence of pre-service teachers in TPACK irrespective of location.

Introduction

Today's teacher educators need to design learning experiences integrating technology for transformative learning. Bringing together the power of deep content knowledge, pedagogical knowledge and technological knowledge in an integrated manner is critical in the design of today's learning experiences. The Technological Pedagogical and Content Knowledge (TPACK) framework assists educators in gaining competency and confidence to design technology-enhanced learning in ways that transform the learning experience for both students and teachers because it "emphasizes the connections among technologies, curriculum content, and specific pedagogical approaches, demonstrating how teachers' understandings of technology, pedagogy, and content can interact with one another to produce effective discipline-based teaching with educational technologies" (Harris, Mishra, & Koehler, 2009, p. 396). TPACK is a framework that identifies the knowledge teachers need, to teach effectively with technology. At the heart of the TPACK framework, is the complex interplay of three principal forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK).

A number of studies (Finger et al., 2013; Hofer & Grandgenett, 2012; Leeman, 2013; Nordin, Davis, & Ariffin, 2013) have indicated that during/after pre-service teachers participation in courses targeted at developing their technology knowledge the elements of TPACK grow. From this it gives the impression that many teacher education programs are already designing for effective technology integration based on the TPACK framework in the pre-service teachers learning experiences in courses and programs. However, it appears that pre-service teachers are building on a continuum of learning to use technology for teaching and learning purposes or as Hoffer and Grandgenett (2012) have

suggested “TPACK may also be a moving target” (p. 101) especially in terms of changes to technology but also recent changes in curriculum.

TPACK has developed from Shulman’s (1986) concept Pedagogical Content Knowledge (PCK) which he defined as “that special amalgam of content and pedagogy that is uniquely the province of teachers” (Shulman, 1987, p. 8). PCK reveals “teachers’ unique knowledge regarding how to integrate content knowledge with appropriate pedagogical approaches in such a way that learners mastered the subject matter at hand” (Brantley-Dias & Ertmer, 2013, p. 106) it includes the ability to diagnose misconceptions, representing or explaining content in a number of ways, and reorganise understandings (Shulman, 1986).

Previous studies (Angeli & Valanides, 2008; Archambault & Barnett, 2010; Graham, 2011) have indicated that often teachers and pre-service teachers have had difficulty distinguishing between TCK and TPK. These difficult concepts are described below:

- Technological Content Knowledge (TCK) is knowledge of the relationship between content and the relevant technology (Koehler, Mishra, Kereluik, Shin, & Graham, 2014) or “knowledge required to identify and select technology tools and resources in a particular content area” (Hofer & Grandgenett, 2012, p. 85).
- Technological Pedagogical Knowledge (TPK) refers to the constraints and affordances technology can provide pedagogical practices (Koehler et al., 2014) or “knowledge that helps teachers to maximize a particular technology’s affordances to support a pedagogical strategy or model” (Hofer & Grandgenett, 2012, p. 85).

Much of the current TPACK research has been completed in the USA (Chai, Koh, & Tsai, 2010) with some recent studies which have occurred in Asia (e.g., Singapore, Taiwan, Malaysia). In addition, Nordin, Morrow and Davis (2011) used the TPACK framework to investigate if pre-service teachers in New Zealand used their field experience to develop their potential to integration ICT through pre and post testing. Their results indicated that this was the case, and that it was important to provide scaffolding for pre-service teachers to conceptualize and expand their understanding of the TPACK concepts. In an international collaborative research project, teacher educators from a University in Australia and a Teaching College in Israel have investigated information and communication technology (ICT) integration using the TPACK framework in their teacher education programs.

Methodology

Data were collected from two pre-service teacher programs located in Australia and Israel. Pre-service teachers in Australia were from a regional university enrolled in either a four year undergraduate initial teacher education program or a graduate diploma of teaching and learning. 85 pre-service teachers completed the survey. Pre-service teachers in Israel were from a regional teacher training college enrolled in a four year undergraduate initial teacher education program, and 99 pre-service teachers completed the survey.

An online TPACK survey was used to collect data. The survey was modified from the one developed by Schmidt et al. (2009) and can be found at http://www.tpack.org/. The survey originally had an elementary focus and it was modified to include a range of disciplines that secondary pre-service teachers could teach beyond Social Studies, Mathematics, Science and English which were included the initial survey. The following disciplines were added to the survey which impact particularly on the Content Knowledge: Languages other than English (LOTE), Computing, The Arts (e.g. Dance, Music, Art, and Drama), Health and Physical Education (HPE), Religion and Business/Tourism. This ensured that elementary and secondary pre-service teachers could complete the survey.

The survey was translated into Hebrew for the Israeli pre-service teachers. Back translation was carried out to ensure that the Hebrew translation was accurate. The survey had three parts, Part A, collected demographic information about the participants e.g. gender, age and secondary teaching areas to provide a contextual background for the data. Part B, used a 5 point Likert scale (Strongly agree – Strongly disagree) where pre-service teachers self-rated their confidence/competency in all 7 elements of TPACK. This data was statistically analyzed using SPSS. Part C, included open ended questions regarding modeling by mentor teachers and university instructors of TPACK or ICT integration, it also provided pre-service teachers with the opportunity to describe their previous experiences and comfort level with teaching with ICTs. This data was analyzed to identify common themes.

This survey was selected because the original survey had been revised based on previous research and included reliability score for each TPACK domain (Schmidt, Baran, Thompson, Mishra, et al., 2009). Also, given that pre-service teacher practices and beliefs are heavily influenced by their past experiences (Niess, 2008) and they also impact on pre-service teachers perceptions and practices in terms of the use of technology in learning and teaching (Ertmer, 2005; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012), it was appropriate to have pre-service teachers self-report as a valid way to collect the data.

Findings and discussion

An analysis of the gender of the participants at both locations surprising revealed the same results with 74% of the participants being female and 26% male. There was a difference in age ranges of the participants with the majority of the Israel participants were school leavers, aged 23 and 25, and in Australia the majority of the participants were aged 32 – 50. This difference could be attributed to the fact that in Australia 62% of the participants were in a Graduate Diploma program, which meant they had a previous degree (usually a previous career) and were completing a one year add on initial teacher education program. The remaining 38% of the Australian participants were in a four year initial teacher education program. In Israel all of the Pre-service teachers were in a four year undergraduate course. When asked if they had participated in professional development which focused on ICT integration (beyond courses in their program), 43% of the Australian pre-service teachers indicated they had already done so; unlike the pre-service teachers from Israel, where only 20% of the participants had previously participated in professional development related to ICT integration.

As indicated in Table 1 below, when combing the elements of CK the Australian pre-service teacher surveys yielded a mean score of 4.34 (SD = 0.57), this was the highest confidence level of all of the TPACK components; with Israel scoring slightly lower with a mean of 4 (SD = 0.21). A similar results was gained for the TK component where Australia (M = 3.8; SD = 0.73) had a higher mean and less variance than Israel (M = 3.55; SD = 0. 98). Overall the TK levels were lower than other components, this parallels the finding of Nordin et al., (2013) and Archambault and Crippen (2009).

TPACK component	**Australia (*N* = 85) Mean (SD)**	**Israel (*N* = 99) Mean (SD)**
Content Knowledge (CK)	4.34 (.57)	4.00 (.21)
Technological Knowledge (TK)	3.80 (.73)	3.55 (.98)
Pedagogical Knowledge (PK)	3.99 (.54)	4.06 (.51)
Pedagogical Content Knowledge (PCK)	4.16 (.59)	4.11 (.90)
Technological Content Knowledge (TCK)	3.96 (.64)	4.02 (.98)
Technological Pedagogical Knowledge (TPK)	3.94 (.52)	3.85 (.76)
Technological, Pedagogical and Content Knowledge (TPACK)	4.02 (.68)	4.00 (.84)

Table 1: *Summary of descriptive statistics for secondary pre-service teachers' TPACK*

The PK construct for the pre-service teachers located in Israel (M = 4.06; SD = 0.51) was at a higher confidence level than the Australian pre-service teachers (M = 3.00; SD = 0.54). As was the TCK component, with Australia having a mean of 3.98 (SD = 0.65) and Israel with a mean of 4.02, however there was a large variance with the standard deviation at 0.98. TPK rated at a lower level with a mean of 3.96 (SD = 0.64) for Australia and 3.85 (SD = 0.76) for Israel, this aligns with the results from Hofer and Grandgenett (2012).

PCK and TPACK had high levels of confidence for the participants, with Australia having a mean of 4.16 (SD = 0.59) and Israel with 4.11 (SD = 0.90) for PCK and a mean of 4.02 (SD = 0.68) and Israel with a mean of 4.00 (SD = 0.84) for TPACK. Nordin et al, (2013) also found high levels of PCK and TPACK.

Table 2 provides an International comparison of TPACK studies involving pre-service teachers within the last six years. These studies also used the survey with a five point scale and published the mean and the standard deviation.

TPACK component Mean (SD)	**Australia (*N* = 85) 2014**	**Israel (*N* = 99) 2014**	**Turkey (*N* = 3105)** (Kabakci Yurdakul & Coklar, 2014)	**US (*N* = 87)** (Schmidt, Baran, Thompson, Koehler, et al., 2009)	**New Zealand (*N* =107)** (Nordin et al., 2013)
CK	4.34 (0.57)	4.00 (0.21)		4.05 (.55)	4.31 (0.68)
TK	3.80 (0.73)	3.55 (0.98)		3.82 (.57)	3.61 (0.68)
PK	3.99 (0.54)	4.06 (0.51)		4.05 (.44)	4.11 (0.60)
PCK	4.16 (0.59)	4.11 (0.90)		3.91 (.56)	4.02 (0.52)
TCK	3.96 (0.64)	4.02 (0.98)		4.06 (.46)	3.97 (0.61)
TPK	3.94 (0.52)	3.85 (0.76)		4.30 (.48)	3.92 (0.63)
TPACK	4.02 (0.68)	4.00 (0.84)	3.84 (0.55)	4.13 (.46)	4.00 (0.61)

Table 2: *International comparison of TPACK components*

When reviewing Table 2 it appears that pre-service teachers from around the world have confidence in their ability to use ICTs for teaching and learning purposes. The highest levels of confidence are in the areas of CK, PCK, and TPACK with means of 4 or above on a 5 point scale in all but one case. The lowest areas of confidence are in TK, and TPK. This study of Australian and Israeli pre-service teachers mirrors the result of those studies complete in Turkey, the US and New Zealand.

Within the open ended questions the Australian and Israeli pre-service teachers were able to provide specific examples within their teacher education program where instructors effective modeled TPACK. These examples came from a wide range of different courses, for example, curriculum and pedagogy courses, content courses, and the internship. From the examples given by the Israeli pre-service teachers it seems that although their teachers at the college demonstrated the use of technology, the teaching itself was traditional, thus there was very little active learning by the pre-service teachers themselves. There was a variety of responses when asked for examples from their professional experience placements. Both Australian and Israeli pre-service indicated in some cases that they had not seen any examples during their school placements, where others had very specific curriculum examples.

Both the Australian and Israeli pre-service teachers indicated that their confidence and competence in using ICTs for learning and teaching is developing over their program. Overall most pre-service teachers were comfortable using ICT for their own purposes, however, even those Australian graduate diploma pre-service teachers who came from the IT industry felt their still had more to learn when using technology for learning and teaching purposes. Some of the Israeli pre-service teachers pointed out that they do better without technology.

When asked to identify a specific learning episode where they integrated ICTs while on professional experience, many of the pre-service teachers gave very traditional teaching examples which were largely about presenting information; for example, using online video clips, PowerPoint, and Interactive whiteboards. Some pre-service teachers did indicate approaches aligned with discipline specific learning such as online laboratory, software for composing music, spreadsheets and graphics calculators and discipline specific software such as MYOB or Auto CAD. Some of the Israeli pre-service teachers did not experience technology integration at all during their teaching experience while others have experienced with a variety of ‘interesting’ technologies such as Pedometers and Cardio apps in HPE and Anatomy apps in science, some utilized clickers as response devices, while others used Brain pop, YouTube, PowerPoint and Smartphone’s for traditional and nonlinear teaching.

Implications

First, pre-service teachers in both contexts were provided with a wealth of experiences using technology in their teacher education programs. Guidance, support and teacher modeling of teaching are seen as key attributes of associate teachers (Cameron & Baker, 2004), it is imperative that effective and contemporary examples are given in pre-service teacher programs because this will be a basis for the development of effective practice.

Second, pre-service teachers need to have effective opportunities to apply the theory of TPACK in the design of their lessons and learning tasks in their course work and in their professional experience. There are issues with inconsistent observation and enactment of TPACK pre-service teachers view while on professional experience placements in schools. The teacher education programs have the responsibility for ensuring appropriate placements with mentor teachers who are themselves confident with the elements of TPACK and can be role models for the pre-service teachers in the use of ICTs for teaching and learning.

During the study it was observed that the participants had high levels of confidence for PCK and TPACK. The lowest areas of confidence were in TK, and TPK within this study and reviewing the international comparison. Technological Knowledge includes knowledge of how to operate digital tools and Technological Pedagogical Knowledge, refers to the pedagogical approaches related to teaching with and about the technology tools. An inhibitor which might impact on the development of these constructs is that when on professional experience placement pre-service teachers will frequently be required to interact with technologies which they have not been exposed to in their teacher education programs due to the wide diversity and the frequency of change in versions and tools available. The lack of technology knowledge limits the effectiveness of their ability to integrate ICTs into their teaching. Teacher education programs must ensure that pre-service teachers' have sufficient knowledge, confidence, and competence in their TK, TCK and TPK in addition to TPACK.

Gaining confidence with any new technology takes more than an initial exposure in class by the course instructor or at the school placement. Teachers' adoption and integration of technology progresses through a series of stages from non-user to expert user (Hooper & Rieber, 1995; Marcinkiewicz, 1993; Sandholtz, Ringstaff, & Dwyer, 1997). Time and experimenting in school placements and academic courses is needed for pre-service teachers to achieve high levels of confidence in TK, TCK and TPK.

Further, what processes are in place to articulate or make concrete the three knowledge areas and the intersections of them in terms of the design and facilitation of learning within technology enable learning environments? The challenge as teacher educators is not only to understand TPACK, but to consider what it looks like in practice in our particular teacher education programs. Pre-service teachers' knowledge of the TPACK components is within the responsibility of the institute preparing them to be teachers. Thus, the teacher educators teaching the pre-service teachers should be well acquainted with the TPACK components and have the pedagogical understanding which is needed in order to meaningfully teach TPACK.

Limitations and Conclusion

Although this study was an international study, it draws from two very different contexts geographically, contextually and culturally. This means that although some international comparisons to other studies have been made, the ability to generalize more broadly about this data is limited. Although the sample size is limited the findings appear to be consistent internationally. The survey used for data collection was based on self-report data rather than observations. As a result, it may be that some of the pre-service teachers did not fully understand the meaning of each of the TPACK components.

The aim of this research was to identify if there are any contextual differences between the levels of TPACK in pre-service teachers from two different countries. Comparing the Israeli to the Australian pre-service teachers indicates that there's a similarity in the TPACK components reported by the pre-service teachers with low levels of TK and TPK. These findings indicate that there are limitations in the teacher training programs and that more attention should be provided to Technological Knowledge and Technological Pedagogical Knowledge in regard to preparing pre-service teachers to teach in the contemporary classroom.

References

Angeli, C., & Valanides, N. (2008). *TPCK in pre-service teacher education: Preparing primary education students to teach with technology.* Paper presented at the Annual Meeting of the American Educational Research Association, New York City, NY.

Archambault, L., & Barnett, J. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers & Education, 55*(4), 1656-1662. doi: 10.1016/j.compedu.2010.07.009

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education, 9*(1), 71-88.

Brantley-Dias, L., & Ertmer, P. A. (2013). Goldilocks and TPACK: Is the Construct" Just Right?". *Journal of Research on Technology in Education, 46*(2), 103-128. doi: 10.1080/15391523.2013.10782615

Cameron, M., & Baker, R. (2004). *Research on initial teacher education in New Zealand: 1993-2004*. Wellington, New Zealand New Zealand Council for Educational Research.

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2010). Facilitating Preservice Teachers' Development of Technological, Pedagogical, and Content Knowledge (TPACK). *Journal of Educational Technology & Society, 13*(4), 63-73.

Ertmer, P. (2005). Teacher Pedagogical Beliefs: The Final Frontier in Our Quest for Technology Integration. *Educational Technology Research & Development, 53*(4), 25-39. doi: 10.1007/BF02504683

Ertmer, P., Ottenbreit-Leftwich, A., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher Beliefs and Technology Integration Practices: Examining the Alignment between Espoused and Enacted Beliefs. In J. Jonig (Ed.), *Teachers Pedagogical Beliefs* (pp. 149-170). Germany: Waxmann.

Finger, G., Albion, P., Jamieson-Proctor, R., Cavanagh, R., Grimbeek, P., Lloyd, M., . . . Romeo, G. (2013). Teaching teachers for the future (TTF) project TPACK survey: summary of the key findings. *Australian Educational Computing, 27*(3), 13-25.

Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Computers & Education, 57*(3), 1953-1960. doi: 10.1016/j.compedu.2011.04.010

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of Research on Technology in Education, 41*(4), 393-416. doi: 10.1080/15391523.2009.10782536

Hofer, M., & Grandgenett, N. (2012). TPACK Development in Teacher Education: A Longitudinal Study of Preservice Teachers in a Secondary MA Ed. Program. *Journal of Research on Technology in Education, 45*(1), 83-106. doi: 10.1080/15391523.2012.10782598

Hooper, S., & Rieber, L. P. (1995). Teaching with technology. In A. Ornstein (Ed.), *Teaching: Theory into practice* (pp. 154-170). Boston: Allyn and Bacon.

Kabakci Yurdakul, I., & Coklar, A. (2014). Modeling preservice teachers' TPACK competencies based on ICT usage. *Journal of Computer Assisted Learning*, 1-13. doi: 10.1111/jcal.12049

Koehler, M., Mishra, P., Kereluik, K., Shin, T., & Graham, C. (2014). The Technological Pedagogical Content Knowledge Framework. In J. M. Spector, M. D. Merrill, J. Elen & M. J. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology* (pp. 101-111). New York: Springer.

Leeman, J. (2013). Guiding Pre-service Teachers Toward Technology Supported Learner-Centered Instruction: Using the TPACK Literature to Inform Teacher Educator Pedagogy. In R. McBride & M. Searson (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2013* (pp. 4983-4988). Chesapeake, VA: AACE.

Marcinkiewicz, H. R. (1993). Computers and teachers: Factors influencing computer use in the classroom. *Journal of Research on Computing in Education, 26*(2), 220-237.

Niess, M. L. (2008). Guiding preservice teachers in developing TPCK. In AACTE Committee on Innovation and Technology (Ed.), *Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators* (pp. 223-250). New York, NY: Routledge for the American Association of Colleges for Teacher Education.

Nordin, H., Davis, N., & Ariffin, T. (2013). A Case Study of Secondary Pre-service Teachers' Technological Pedagogical and Content Knowledge Mastery Level. *Procedia-Social and Behavioral Sciences, 103*, 1-9. doi: 10.1016/j.sbspro.2013.10.300

Nordin, H., Morrow, D., & Davis, N. (2011). Pre-Service Teachers' Experience with ICT Integration in Secondary Schools: A Case Study of One New Zealand Context. In M. Koehler & P. Mishra (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2011* (pp. 3915-3920). Chesapeake, VA: AACE.

Sandholtz, J. H., Ringstaff, C., & Dwyer, D. (1997). *Teaching with technology: Creating student-centered classrooms*. New York, NY: Teachers College Press.

Schmidt, D., Baran, E., Thompson, A., Koehler, M., Punya, M., & Shin, T. (2009). *Examining preservice teachers' development of technological pedagogical content knowledge in an introductory instructional technology course.* Paper presented at the Society for Information Technology & Teacher Education International Conference, Charleston, SC.

Schmidt, D., Baran, E., Thompson, A., Mishra, P., Koehler, M., & Shin, T. (2009). Technological Pedagogical Content Knowledge (TPACK) The Development and Validation of an Assessment Instrument for Preservice Teachers. *Journal of Research on Technology in Education, 42*(2), 123-149. doi: 10.1080/15391523.2009.10782544

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

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard educational review, 57*(1), 1-23.