

Title: Exploring TPACK among preservice teachers in Australia and Israel

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Abstract:

The ubiquitous nature of technology in the world has not yet translated into the ubiquitous use of technology to transform learning and teaching. Teachers lack the confidence and competence to integrate technology across a broad range of tools within a range of contexts. Technological Pedagogical Content Knowledge (TPACK) has become a common framework to explore technology within teaching and teacher education. However, little research exists to explore the similarities and differences of TPACK between different teacher education programs, within different countries or even different disciplines, especially in a secondary context. Using a self-report online survey, this study sought to compare and contrast TPACK results from pre-service teachers studying in secondary teacher education programs in Australia and Israel. Findings suggest that TPACK is higher in Australia, and in both countries for those students who were aged over 26. There were no significant differences between gender or disciplines reported. The paper also discusses broad-scale implications for the future of research in TPACK.

Keywords: TPACK, secondary, teacher education, preservice, Australia, Israel, technology, ICT

Introduction

Planning and teaching is a complex and messy activity where teachers integrate knowledge and skills from multiple domains (Magnusson, Krajcik & Borko, 1999). These domains include depth and breadth of content knowledge; general pedagogical knowledge; curriculum knowledge; pedagogical content knowledge; knowledge of learners and their characteristics; knowledge of educational contexts; and knowledge of educational ends, purposes, and values, and philosophical and historical backgrounds (Shulman, 1987). These knowledges are all bound within the context of the classroom (either real or virtual).

The complex ways that teachers represent information for learners to understand is known as Pedagogical Content Knowledge (PCK). Shulman (1987) commented that PCK is “that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding” (p. 8).

The role of teacher education is to provide opportunities for pre-service teachers to gain knowledge and skills in a broad range of areas. Today’s professional teacher knowledge includes the practical use of technology for learning and teaching. Technology is now integral to education in all sectors, and teacher education programs have implemented technologies in a range of ways, including integration across a whole program, specific one-off digital technology courses or embedding of technology within specific courses such as content method courses. Technological Pedagogical Content Knowledge (TPACK) “connects technology to curriculum content and specific pedagogical approaches and describes how teachers’ understandings of these three knowledge bases can interact with one another to produce effective discipline-based teaching with educational technologies” (Koehler, Shin, Mishra, 2012, p. 17).

Numerous studies have explored teacher and preservice teacher integration of ICT and the TPACK framework in elementary contexts. This study sought to compare and contrast TPACK results from pre-service teachers studying in secondary teacher education programs in Australia and Israel using a self-report online survey.

TPACK

TPACK builds on the PCK construct and is “achieved when a teacher knows how technological tools transform pedagogical strategies and content representations for teaching specific topics” (Jang, 2010, p. 1744). An understanding of the intricate relationships between technology, pedagogy, and content knowledge result in the development of unique learning experiences. Each of the elements of TPACK are briefly defined in table 1 below.

Table 1
Summary of TPACK constructs

TPACK construct	Definition
Content knowledge (CK)	Knowledge about the actual subject matter that is to be learned or taught
Pedagogical Knowledge (PK)	Deep knowledge about methods of teaching and learning
Pedagogical Content Knowledge (PCK)	The blending of content and pedagogy into an understanding of how particular topics are presented for instruction
Technology Knowledge (TK)	Knowledge of how to use technological tools such as hardware, software and the web
Technological Content Knowledge (TCK)	Knowledge about the manner in which technology and content are reciprocally related
Technological Pedagogical Knowledge (TPK)	Knowledge of technologies that may be used for learning and teaching and how teaching might change as the result of using technologies
Technological Pedagogical & Content Knowledge (TPACK)	Knowledge required to teach effectively with technology.

Research into TPACK has resulted in a number of ways to measure TPACK using both qualitative and quantitative methods. Some studies investigate TPACK across four elementary disciplines (Maths, Social Studies, Science, and Literacy) where others have focused only on one discipline. Some studies have relabelled or extended the TPACK concept. For example, ICT-TPCK (Angeli, & Valanides, 2009); World Wide Web TPACK or TPCK-W (Lee & Tsai, 2010); electronic PCK or ePCK (Franklin, 2004) and TPACK-Deep (Kabakci, Odabasi, Kilicer, Coklar, Birinci & Kurt, 2012). Recently, Drummond & Sweeney, (2017) explored if the relationships between objective-TPACK and TPACK-Deep provide a broader indicator of pre-service teachers competence and confidence of TPACK.

Overwhelmingly, the bulk of the TPACK research is set in elementary classrooms and within the United States. Geographically research in other areas does exist, principally in Asia (Chang, Tsai, & Jang, 2014), Australia (Redmond, & Lock, 2013; Reyes, Reading, Rizk, Gregory & Doyle, 2016), New Zealand (Nordin, Davis & Ariffin, 2013) and Turkey (Karadeniz, & Vatanartiran, 2013). From a secondary pre-service teacher perspective it appears that the research has primarily mirrored elementary studies focusing on the discipline areas such as Maths (e.g., Bhagat, Chang, & Huang, 2017) and Science (e.g., Chang, Tsai, & Jang, 2014; Habowski & Mouza, 2014).

Over time, research into secondary pre-service teachers' TPACK has included Computer Sciences or use of digital tools such as smart boards (e.g., Doukakis, Psaltidou, Stavraki, Adamopoulos, Tsiotakis & Stergou, 2010; Jang & Tsai, 2012); English as a foreign language (Tseng 2016), and Geography (Su, Huang, Zhou & Chang, 2017) often focusing on the construction of a TPACK scale specific to that discipline context.

Research Context

Little research has investigated TPACK across the broad range of disciplines within secondary schools, and fewer studies still have explored comparative research between teacher education programs in different countries. A university in Australia collaborated with a teaching college in

Israel to explore TPACK within the secondary pre-service teacher context. This research sought to compare and contrast TPACK results from pre-service teachers studying in secondary teacher education programs in Australia and Israel. It will present the similarities and differences of TPACK between different teacher education programs within different countries and explore differences between disciplines.

Australia

This study took place at a regional Australian university where 70% of the pre-service teachers studied online. The pre-service teachers were exposed to ICT integration experiences in three ways across the program. Firstly, in the first half of the program general curriculum and pedagogy courses introduce technology for teaching and learning in generic ways. Secondly, in the second half of the program discipline-specific curriculum and pedagogy courses investigate content-specific technology use. Finally, there is a specific technologies course which builds on generic concepts and requires pre-service teachers to further develop discipline technological skills and to implement technologies within a professional experience placement. This variety of opportunities provide pre-service teachers with numerous opportunities across their program to consider their discipline context and pedagogy in light of technology affordances. The participants (N=84) in this study were in the first half of their program, either in a one year after degree (64% of the Australian participants) or a four-year undergraduate degree (36%).

Israel

The study took place in a small rural college of education in the northern part of Israel. All of the participants studied on campus (N=125). In general, about 25% of the courses were online. The teacher training program is a four-year program which can be divided into three parts. The first part is the discipline knowledge section which is course-based and lasts the whole four years. The second part is 'basics of teacher training' which starts in the second semester of the first year on campus. The third part is a continuation of teacher training in schools (one day a week) for the whole duration of the second, third and fourth year. The college where the data were collected took upon itself to promote technology into education as part of a nationwide initiative. As such, the college integrates numerous technology-related courses in the syllabus from the first semester. The pre-service teachers are required to integrate technology in their teaching plans and demonstrate the benefits of technology in their respective teaching experiences at school and show the added value of the proposed technology for the specific content learning unit they teach.

Methodology

A case study approach was taken to explore the contextual and discipline differences between pre-service teachers in Australia and Israel. Case study has been defined by Merriam and Tisdell (2016) as "an in-depth description and analysis of a bounded system" (p. 37). Data were collected for this research using an online survey which was selected because it had been validated as a TPACK assessment instrument for pre-service teachers. The TPACK survey developed by Schmidt et al. (2009) was modified go beyond the elementary focus of Maths, Social Studies, Science, and Literacy to include additional disciplines relevant for secondary education in the Australian and Israeli contexts. These disciplines included: History, Computing, Languages other than English (LOTE), Health and Physical Education (HPE), The Arts (e.g., Dance, Music, Art, and Drama), Science and the environment, English as a secondary language, Outdoor education, and Religious education.

The survey was created with two parts. The first part of the survey collected demographic information including age, gender, program of studies and which teaching areas the pre-service teachers majored in. The second part of the survey required the pre-service teachers to self-report on their TK, CK, PK, PCK, TCK, TPK and TPACK from a 5 point Likert scale (Strongly agree - Strongly disagree). It also included statements about their observation of TPACK modeling through teaching and learning at their university and within professional experience placements. The survey was translated into Hebrew, and a back translation was carried out to ensure the accuracy of the translation for the Israeli pre-service teachers. After ethics approval, the online survey was made available for the participants.

This study was guided by the research questions:

1. What are the similarities and differences in TPACK of pre-service teachers in Australia and Israel?
2. What are the similarities and differences between disciplines in TPACK of pre-service teachers?

Findings

Demographic information

The survey was completed by 209 pre-service teacher participants, 60% were from Israel and 40% from Australia. The majority of the participants (73%) were female, and the ratio of male to female participants between Australia and Israel was the same. The average age of the participants in Australia were older than in Israel, with 58% of the participants aged 32 and over, compared to 55% aged between 23-26 in Israel. Overall 18% of the participants were aged between 18-22; 35% were aged 23-26; 19% per aged 27-32 and 29% were 32 or older. Table 2 provides a summary of the discipline or teaching areas of the pre-service teachers. Social science and humanities disciplines where most highly represented.

Table 2

Summary of teaching areas for the secondary pre-service teachers

Country	Social Sciences & Humanities	Mathematics & Sciences	Health & Physical Education	The Arts
Israel	50%	11%	36%	Nil
Australia	21%	37%	8%	11%
Total	30%	29%	16%	8%
Country	Computing & Design Technologies	Business	Special Education	
Israel	Nil	Nil	3%	
Australia	6%	13%	4%	
Total	4%	9%	4%	

Internal reliability of the survey

Because the survey was modified from a previous one, a factor analysis on the TPACK variables was undertaken, and it was considered factorable (KMO=.846). Thirty-six statements examined the level of TPACK. Table 3 provides a summary of the descriptive statistics and internal reliability analysis for TPACK and TPACK components.

Table 3

Descriptive statistics and internal reliability analysis for TPACK and TPACK components

Variable	Mean	S.D.	Cronbach's alpha reliability	Score (on a scale from 1 to 100)
TPACK	3.69	0.48	0.92	74
TK	3.63	0.89	0.90	73
CK	4.10	0.69	0.77	82
PK	4.08	0.59	0.80	82

Variable	Mean	S.D.	Cronbach's alpha reliability	Score (on a scale from 1 to 100)
PCK	4.04	0.56	0.79	81
TCK	3.91	0.79	0.87	78
TPK	3.87	0.72	0.90	77
TPACK models	3.42	0.92	0.83	68
TPACK frequencies	2.65	0.87	0.84	53

Note: $n=209$

The score of all of the TPACK models and frequencies were low while the frequencies of TPACK and its six components were moderate. The Cronbach's alpha reliability was high, indicating the high internal consistency of the nine variables examined (table 3).

Table 4

Pearson Correlation matrix of the TPACK components

Variable	1	2	3	4	5	6	7
1. TK	==	==	==	==	==	==	==
2. CK	0.302***	==	==	==	==	==	==
3. PK	0.135~	0.102	==	==	==	==	==
4. PCK	0.214**	0.078	0.594***	==	==	==	==
5. TCK	0.485***	0.255***	0.293***	0.448***	==	==	==
6. TPK	0.435***	0.249***	0.244***	0.447***	0.683***	==	==
7. TPACK models	0.223**	0.193**	-0.024	0.154*	0.165*	0.267***	==
8. TPACK frequencies	0.263***	0.224**	0.006	0.091	0.183**	0.192*	0.597***

Note: $n=209$, ~ $p<0.06$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Correlation coefficient matrix representing the relationship between the TPACK components are presented in Table 4. A significant positive correlation was found between TK and CK, PCK, TCK, TPK, TPACK models, TPACK frequencies; CK and TCK, TPK, TPACK models, TPACK frequencies; PK and PCK, TCK, TPK; PCK and TCK, TPK, TPACK models; TCK and TPK, TPACK models, TPACK frequencies; TPK and TPACK models, TPACK frequencies; TPACK models and TPACK frequencies. A negative non-significant correlation was found between TPACK models and PK. Overall, this suggests that the TPACK components were correlated but distinct from one another and that the online survey was appropriate to evaluate the secondary pre-service teachers TPACK.

TPACK Differences between countries

An independent sample t-test was conducted for the difference in TPACK and TPACK components between countries (see table 5). A significant difference between the two countries regarding TPACK and its components was found, such that the TPACK and its components in Australia are significantly

higher than in Israel. A small (0.2-0.5) Cohens' D effect was found for TPACK and TK and a medium (0.5-0.8) Cohens effect was found for CK, TPACK models and TPACK frequencies indicating a significant difference between countries in these variables.

Table 5

Description the difference between countries regarding TPACK components

	Country	N	Range	Mean	S.D.	T-test	Cohen's d
TPACK	Israel	126	4.72 - 1.97	3.60	0.51	*2.26*	0.47
	Australia	83	4.81 - 2.92	3.81	0.38		
TK	Israel	126	5.00 - 1.00	3.52	0.96	*2.28	0.34
	Australia	83	5.00 - 2.00	3.81	0.74		
CK	Israel	126	5.00 - 1.67	3.96	0.74	*3.68**	0.55
	Australia	82	5.00 - 2.67	4.32	0.57		
PK	Israel	126	5.00 - 1.00	4.09	0.61	0.40	==
	Australia	83	5.00 - 2.33	4.06	0.56		
PCK	Israel	126	5.00 - 1.60	4.09	0.57	1.53	==
	Australia	83	5.00 - 2.40	3.97	0.54		
TCK	Israel	126	5.00 - 1.00	3.87	0.51	1.00	==
	Australia	83	5.00 - 2.67	3.89	0.56		
TPK	Israel	126	5.00 - 1.38	3.82	0.82	1.16	==
	Australia	83	5.00 - 2.38	3.94	0.53		
TPACK models	Israel	126	5.00 - 1.00	3.19	1.01	*4.49**	0.68
	Australia	83	5.00 - 1.00	3.75	0.64		
TPACK frequencies	Israel	126	4.60 - 1.00	2.44	0.90	*4.55**	0.65
	Australia	83	4.20 - 1.20	2.97	0.72		

Note: n=209, *p<0.05, **p<0.01, ***p<0.001

Age and gender differences

An analysis of the TPACK difference depending on age showed no differences among different age groups in either in Israel or Australia nor was there any difference between the two countries. However, when the age groups were divided into two groups 18-26 and 26+ significant differences were found between the whole sample, but not in the country samples. This was true for TPACK overall and the TPACK components. An independent sample t-test was conducted for the difference

in TPACK between age groups. A significant difference between the two age groups was found, such that the TPACK in age group of 27 and up is significantly higher ($M = 3.77$) than in age group of 18-26 ($M = 3.61$) [$t_{(207, 0.95)} = 2.34$, $p < 0.05$, Cohen's $d = 0.34$]. A small (0.2-0.5) Cohens'D effect was found for TPACK and TK and a medium (0.5-0.8) Cohens'D effect was found for CK, TPACK models and TPACK frequencies indicating a significant difference between countries in these variables. (Table 6).

Table 6

Description the difference between countries regarding TPACK within age groups

	Age group	Country	N	Range	Mean	S.D.	t	Cohen's d
TPACK	18-26	Israel	94	1.97 - 4.58	0.59	0.49	0.95	==
		Australia	14	2.92 - 4.14	3.73	0.36		
	27 and up	Israel	32	2.42 - 4.72	3.62	0.56	2.25*	0.44
		Australia	69	3.00 - 4.81	3.83	0.39		
TK	18-26	Israel	94	1.17 - 5.00	3.54	0.89	0.82	==
		Australia	14	2.17 - 5.00	3.75	0.71		
	27 and up	Israel	32	1.00 - 5.00	3.45	1.17	1.91~	0.38
		Australia	69	2.00 - 5.00	3.82	0.75		
CK	18-26	Israel	94	1.67 - 5.00	3.93	0.76	0.21	==
		Australia	14	2.67 - 5.00	3.98	0.56		
	27 and up	Israel	32	2.00 - 5.00	4.05	0.68	2.61*	0.55
		Australia	68	3.00 - 5.00	4.39	0.55		
PK	18-26	Israel	94	1.00 - 5.00	4.06	0.61	1.06	==
		Australia	14	4.00 - 5.00	4.24	0.35		
	27 and up	Israel	32	2.33 - 5.00	4.21	0.59	1.41	==
		Australia	69	2.33 - 5.00	4.03	0.59		
PCK	18-26	Israel	94	1.60 - 5.00	4.09	0.56	0.42	==
		Australia	14	3.40 - 5.00	4.03	0.43		
	27 and up	Israel	32	2.80 - 5.00	4.08	0.60	0.99	==
		Australia	69	2.40 - 5.00	3.96	0.57		
TCK	18-26	Israel	94	1.33 - 5.00	3.86	0.84	0.31	==
		Australia	14	3.00 - 4.67	3.78	0.48		
	27 and up	Israel	32	1.00 - 5.00	3.89	1.09	0.74	==
		Australia	69	2.67 - 5.00	4.02	0.57		
TPK	18-26	Israel	94	1.38 - 5.00	3.82	0.79	0.32	==

	Age group	Country	N	Range	Mean	S.D.	t	Cohen's d
	27 and up	Australia	14	2.38 - 4.88	3.76	0.63	1.26	==
		Israel	32	1.63 - 5.00	3.80	0.88		
		Australia	69	2.38 - 5.00	3.97	0.50		
TPACK models	18-26	Israel	94	1.00 - 5.00	3.16	0.99	2.52*	0.59
		Australia	14	2.33 - 4.33	3.62	0.57		
	27 and up	Israel	32	1.33 - 5.00	3.31	1.04	2.75**	0.57
		Australia	69	1.00 - 5.00	3.78	0.65		
TPACK frequencies	18-26	Israel	94	1.00 - 4.60	2.42	0.88	2.26*	0.77
		Australia	14	1.80 - 3.60	2.97	0.54		
	27 and up	Israel	32	1.20 - 4.20	2.48	0.97	2.78**	0.57
		Australia	69	1.20 - 4.20	2.97	0.76		

Note: n=209, **p<0.01

This study found that when comparing the two countries TPACK and the TPACK components were higher in Australia when compared with Israel. Also, a two-way-ANOVA (GLM) test was conducted for the difference in TPACK between countries and gender. No significant gender differences were found.

Discipline differences

This study also aimed to compare discipline differences. An independent sample Mann-Whitney U test was conducted for the difference between countries regarding the TPACK components in each of the Major teaching areas. Table 7 provides comparisons between components, sample teaching areas, and countries. No significant differences were found between countries or between teaching areas, this could be because the effect for the overall population is small.

Table 7

Description of the differences between the countries according to the TPACK components in sample teaching areas.

Subject	TPACK	Israel Mean	Australian Mean
Math and Sciences	TK	3.79	3.63
	CK	4.41	4.33
	PK	4.08	3.79
	PCK	4.20	3.70
	TCK	4.08	3.78
	TPK	4.15	3.81
	TPACK	3.75	3.77

Subject	TPACK	Israel Mean	Australian Mean
Humanities and Social Studies	TK	3.61	3.59
	CK	3.94	4.09
	PK	3.96	4.10
	PCK	3.84	3.87
	TCK	3.85	4.03
	TPK	3.38	3.92
	TPACK	3.33	3.56
HPE	TK	3.26	3.83
	CK	4.07	3.61
	PK	3.92	4.02
	PCK	4.00	3.96
	TCK	3.71	3.88
	TPK	3.66	3.68
	TPACK	3.02	3.33

Ongoing professional learning of TPACK

When asked which component of TPACK they need to most improve, despite earlier indicating a reasonably high level of confidence with their CK, the majority of Australian respondents indicated that CK was the TPACK element required improvement, represented by the comment “CK – [I’m] pretty confident with PK and TK. Overall, everything is stuck if you don’t know your content”. Conversely, despite having expressed less confidence with TK, only one student indicated that TK was an area which would be a primary focus of improvement. Most of the pre-service teachers from Israel indicated they needed to improve the TK the most with 1 pre-service teachers revealing that “I have not been exposed to enough technology.”

From both countries, pre-service teachers saw professional experience as the primary context for developing their TPACK skills with one Australian pre-service teacher commenting “You learn best when you are actually teaching, actually using the model ... easiest to identify areas of weakness when actually teaching ... pracs are scattered so hard to maintain focus ... [it will] be easier [to use the model] when I am actually teaching”. This was reaffirmed by other pre-service teachers who suggested “I think a lot of my knowledge will come through practical experience, feeding off the knowledge of experienced teachers” and “pedagogy will come in time as I will be teaching.” The respondents did also reflect that during their teacher education program, further readings and ongoing professional development were other ways they would enhance their TPACK.

In the open-ended survey questions, the secondary pre-service teachers were asked to identify where they have seen good examples of TPACK. Overwhelmingly, the Australian pre-service teachers saw the professional experience as the best context for developing their capacity to use the TPACK framework. Pre-service teacher M indicated that “It is probably the biggest area of learning for me – it’s where I am picking up most of my TPACK knowledge. Being on the grounds and seeing it done

in the classroom. There is no substitute for that experience – you can see why it actually works” and another stated, “My instructor at school is a very skilled teacher with a lot of experience, she uses a lot of technology in her teaching.” Due to its importance as a learning opportunity, the quality of the professional experience mentor was seen as critical. The pre-service teachers from both countries also indicated that education faculty courses provided good examples of a TPACK approach in course delivery, especially when compared to their discipline courses. Many specific teacher educators and courses were mentioned, Pre-service teacher G remarked that one of the teacher educators” had a good combination of technology and pedagogy in the classroom. I’ve only really seen good examples in education”. However, they did also mention experiencing “death by PowerPoint.” They perceived their discipline courses as a venue to develop CK but not the other components of TPACK.

Discussion

The purpose of this study was to compare and contrast TPACK of pre-service teachers from Australia and Israel.

Similarities and differences in TPACK

In answering the first research question: What are the similarities and differences in TPACK of pre-service teachers in Australia and Israel? There was a significant difference in TPACK between the two countries. TPACK in Australia was consistently higher than in Israel. A significant difference between the two countries regarding TK and CK was found, again with Australia being higher than in Israel.

Additionally, pre-service teachers in Australia observed models of TPACK more often than those in Israel. This may have been influenced by a series of strategies in Australian to promote teaching with technology; including the Teaching Teachers for the Future project (Australian Government, 2010) which was a national project aimed to develop ICT capability of pre-service teachers in every teacher education program. The Israeli Ministry of Education also launched the National ICT Reform in 2010. In 2013, nine colleges of education adopted the reform by paying attention to the importance of ICT integration from the pedagogical aspect (Goldstein & Tessler, 2017). This project indicates that Israel is behind Australia regarding ICT implementation in teacher education.

There were no differences in TPACK between Australia and Israel pre-service teachers according to age. However, in the total sample, when grouped as over 26 and under 26 there was a difference in the TPACK results based on the participants self-reporting. Those pre-service teachers, in both countries, over the age of 26 reports higher levels of TPACK and TPACK components when compared to the 18-26 age group. In contrast, Lin, Tsai, Chai, and Lee, (2013) found that there was a negative correlation between the age of science teachers and the factors of TPACK.

There were no significant differences between genders. In contrast, Jang and Tsai (2013) found significant differences according to gender when examining the TPACK of secondary science teachers. Where male teachers self-rated themselves higher than female teachers in the area of TK.

The differences between the two countries could be a result of different expectations. For example, in Australia, there is national accreditation for all initial teacher education programs with defined standards related to ICTs. The variances could also be a function of the student enrolment mode where in Australia 70% of the pre-service teachers were studying online, compared to only 25% in Israel, this may result in increased confidence and competence in using ICTs which would be reflected in the data.

Similarities and differences between disciplines

The second research question asked: What are the similarities and differences between disciplines in TPACK of pre-service teachers? Results of this self-report study found that there are no significant differences between the TPACK components and TPACK in disciplines between the two countries. Surprisingly, there is also no significant difference in discipline between disciplines for the secondary

pre-service teachers. Previous research which explores TPACK for secondary pre-service teachers is limited to one discipline (e.g., Jang, 2010; Habowski & Mouza, 2014) rather than comparing disciplines, so it is unknown whether this result is due to the small sample size or it is a common outcome in secondary teacher education. Other secondary studies investigated teacher education programs overall (e.g., Hofer & Grandgenett, 2012; Koh, Chai & Tsai, 2010).

Implications

The TPACK framework allows researchers and educators to make inferences about educational technology and may allow us to make predictions about practical approaches for using technology in teaching and learning (Koehler, Shin, Mishra, 2012). It is from this basis that we provide the following implications, acknowledging that “measuring performance does not automatically lead to insights as to what policy and practice can do to help students learn better [and] teachers teach better” (Barber & Mourshed, 2007, p.4).

Although the TPACK construct provides a framework to address how CK, PK, and TK “interact, constrain, and afford each other” (Keohler et al., 2014, p. 102) teacher educators and researchers continue to use the framework to design teacher education or teacher professional learning programs and to measure TPACK from a one-off perspective. The authors question how this is improving learning and teaching with technology. Measuring TPACK is like high stakes testing in schools – it provides a data from a point in time. At an individual pre-service teacher, course or even program level, what does the measurement really tell us? How does it value add? What are we doing with the data? Does it inform continued improvement in teacher education courses? How can we learn from those programs that have consistently high levels for all the TPACK components and overall TPACK? What are the pedagogical practices and the instructional design features that might enhance TPACK?

Perhaps we should consider TPACK assessments over four years and provide some longitudinal data to identify trends within programs or tracking individual or cohort student development. “The quality of an education system cannot excel the quality of its teachers” (Barber & Mourshed, 2007, p. 7) this could be extrapolated to teacher education in that the quality of the teacher education program cannot exceed those of its teacher educators. Internationally, there is a range of approaches to designing for TPACK understanding. Currently, we fail to learn from other teacher education programs to explore how to articulate and make concrete the three knowledge areas (CK, PK & TK) and their intersections when designing for technology-enhanced learning for pre-service teachers.

The challenge is to not only understand TPACK but examine what it looks like in practice in different teacher education programs. There is an implication for teacher education programs to improve the quality of faculty TPACK in order to increase pre-service teacher TPACK. This aligns with the findings of Tondeur, van Braak, Sang, Voogt, Fisser, & Ottenbreit-Leftwich, (2012) who recommended that teacher educators act as role models for pre-service teachers. Also, role modeling may also mediate differences between age groups as found in this study. Teacher educators and pre-service teachers need a clear understanding of technological and pedagogical affordances within their discipline areas.

Limitations and Future Research

One of the limitations of this study was that the research was conducted at two regional universities and the participants may not be representative of all PSTs within those countries. Another limitation of the study is the small sample size which reduces the ability to make generalisations. Finally, like most TPACK studies, this study provides data from a single point in time and does not provide evidence of growth over the duration of the teacher education programs.

Future research between the two countries could explore pre and post-tests to check for growth and compare that between countries and disciplines. Also, a national or global study to explore TPACK at

a much broader level would provide very large sample sizes and the ability to make generalisations. This would require a major commitment by teacher education programs and would also require those involved to seek agreement on how to measure TPACK. There is a call for reproducible research in all disciplines (e.g., Hostetler, 2005; Mesirov, 2010; Peng, 2011) and we should be looking for ways to enact it at national and international levels.

In addition, research could investigate if TPACK there a difference between the hard sciences (maths, science, engineering, technology) and soft sciences (English, social studies: history, geography, legal studies, and languages)? This may be possible using the data which has already been collected in published studies.

Perhaps further studies could identify and share pedagogical practices that result in high levels of each of the seven components of TPACK. A final future consideration is to assess the TPACK of the teacher educators, perhaps in concert with the pre-service teachers, as this may provide information about how teacher educators see themselves as teachers with or of technology, and also how their students the pre-service teachers perceive their knowledge and skills with technology.

Conclusion

A regional university in Australia collaborated with a teaching college in Israel to explore TPACK differences between countries and disciplines areas within the secondary pre-service teacher context. Within this study provides a unique exploration of TPACK comparing differences in TPACK between the two countries and between disciplines within secondary pre-service teacher education. TPACK was found to be higher in Australia, and in both Australia and Israel TPACK was found to be higher in those students who were aged over 26 years.

A comparative approach to studying TPACK provides an opportunity to explore the phenomena of TPACK beyond a single site or case. If this approach is extended to multiple sites, it provides the ability to draw generalisation inferences from the data rather than report on what happens at a single site. When research is reproduced in multiple places, it not only assists in the modification or development of more robust data collection tools but also provides the ability to report more broadly on the phenomena being studied. This broader outlook on the concept of TPACK contributes to researchers and practitioners more fully understanding the development of TPACK in pre-service teachers.

The authors question what is next for TPACK? How do researchers move beyond single context studies? Given the large volume of work on TPACK, the addition of other single context study is unlikely to move the field forward. The authors would value interest from others to create an international collaborative research team to explore these future ideas. If you are interested, please contact us.

Statements on open data, ethics, and conflict of interest

- a. The data cannot be accessed as it is not stored online.
- b. Permission was granted to carry-out this research by the IRB of the University of Southern Queensland, Australia and the Western Galilee College, Israel.
- c. There is no conflict of interest in the work we are reporting here.

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