Pre-service Teachers' TPACK Confidence in a Regional Australian University

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Abstract: The extent of transformation of education by integration of ICT appears not to match that in other sectors. More effective preparation of teachers is widely assumed to be part of any solution, leading to interest in what knowledge, skills and dispositions are required of teachers and how best to develop those. The Australian Teaching Teachers for the Future (TTF) project appears to have demonstrated some success in enhancing pre-service teachers' TPACK confidence. This paper presents data from a regional Australian university where the change appears to have preceded implementation of TTF and considers factors that may have contributed to that change.

Introduction

The widespread adoption of Information and Communication Technology (ICT) has transformed many aspects of life, including economic and social activity, in developed countries and is affecting the path of development in all parts of the world. However, expectations that education should be transformed by ICT have seldom been realised to the anticipated extent, despite considerable ongoing investments in hardware, software and preparation of teachers. Research into the factors that influence teachers' use of ICT to support learning and teaching is informing ongoing development of teacher preparation programs. This paper examines the experience of teacher preparation in one regional university in Australia against the context of a significant national initiative for advancing the application of ICT in education.

When the Australian Labor Party was elected to national government in late 2007 it included in its platform a policy described as the Digital Education Revolution (DER), intended to achieve a national vision for ICT in education (DEEWR 2008). The vision called for all students to graduate with relevant knowledge and skills for using ICT and for learning to be enhanced by integration of ICT. That was consistent with what had been agreed nationally at the turn of the century but had been left to the states and territories for separate implementation. Following the election the relevant state and federal ministers agreed that "Australia will have technology enriched learning environments that enable students to achieve high quality learning outcomes and productively contribute to our society and economy" (MCEECDYA 2008, p. 1).

As is often the case with ICT in education there was a focus on tangible outcomes such as hardware and one of the most visible elements of the DER was funding to increase the provision of computers in schools to a ratio of 1:1 for years 9 to 12 by 2011. However, despite the initial thrust of the DER toward provision of equipment, the implementation roadmap recognized that "educators require the pedagogical knowledge, confidence, skills, resources and support to creatively and effectively use online tools and systems to engage students" (AICTEC 2009, p. 6). The document noted the importance of providing "professional learning opportunities for existing teachers to upgrade or develop proficiency in the effective and innovative/creative educational use of ICT" and ensuring "that the national graduate teacher standards include rigorous requirements regarding the use of technology in teaching" (AICTEC 2009, p. 8).

The importance of preparing teachers to work effectively with ICT was not a new insight. There is widespread acknowledgement that teacher quality is the most important factor in quality learning for students and a report commissioned by the OECD noted that "the quality of an education system cannot exceed the quality of its teachers" (Barber & Mourshed 2007, p. 7). Australian programs for teacher preparation and development have addressed ICT integration for more than 20 years and have, at times, benefited from targeted government support. However, what was proposed in this instance was a concerted national effort with substantial funding in support.

Teacher preparation for working with ICT

Researchers seeking to enhance integration of ICT for learning through better understanding of factors that facilitate or inhibit teachers' uptake of ICT have identified both external, institutional factors such as access to ICT and supportive administration, and internal, personal characteristics as important (Ertmer 1999). Teacher beliefs, especially a sense of efficacy or confidence in being able to perform the behaviors necessary for success, have long been identified as influencing teacher integration of ICT for learning (Albion & Ertmer 2002; Ertmer 2005; Ertmer & Ottenbreit-Leftwich 2010). More recent work has argued that teachers' own experiences of learning in school and teacher preparation programs set the pattern for how they behave in their own classrooms (Belland 2009).

However, despite the research and associated efforts to better prepare teachers for working with ICT, computers in schools are still seen by some as "oversold and underused" (Cuban 2001). Moreover, teaching with ICT has been described as a "wicked problem" (Mishra & Koehler 2007), one that is complex and ill-structured, with constantly changing context and problem definition, and little or no agreement among experts about solutions. ICT skills and positive attitudes are necessary but not sufficient conditions for teachers to solve such problems.

The knowledge required for teaching is multi-dimensional. Shulman (1986) proposed that, in addition to content knowledge (CK) and pedagogical knowledge (PK), teachers required Pedagogical Content Knowledge (PCK), a blend of knowledge that enables teachers to make strategic decisions about how to represent content for effective learning in a given context. Although Shulman did not represent PCK diagrammatically it has conventionally been shown as a Venn diagram with PCK in the intersection of two circles representing CK and PK. Mishra and Koehler (2006) argued that technology (ICT) has changed the classroom sufficiently that the concept of PCK should be extended to include technological knowledge (TK). They extended the Venn diagram widely used to represent PCK to include TK and additional intersections as shown in Figure 1. The most complex knowledge, the region giving rise to "wicked problems", is where all three circles intersect representing Technological Pedagogical Content Knowledge (TPCK). An "A" was subsequently added to make the acronym pronounceable (Thompson & Mishra 2007, p. 38). TPACK is the knowledge likely to be required of teachers working with ICT and hence should be a focus of teacher preparation.

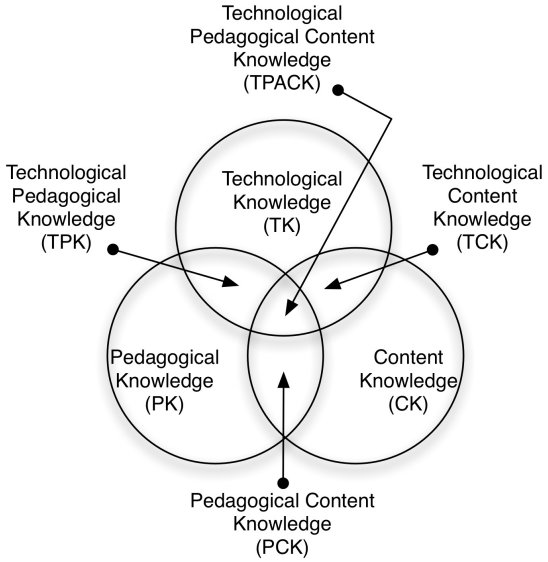

Figure 1: Technological Pedagogical Content Knowledge (TPACK) [after Mishra and Koehler (2006)]

Teaching Teachers for the Future

Strategies for achieving the goals of the Australian Government's DER included an ICT Innovation Fund (DEEWR 2010) for which the successful bid for addressing pre-service teacher education was led by a group acting for the Australian Council of Deans of Education and representing all 39 Australian teacher preparation providers. The *Teaching Teachers for the Future* (TTF) project comprised three components, namely, extending the Australian Institute for Teaching and School Leadership (aitsl.edu.au) graduate teacher standards to include ICT dimensions,

developing professional learning packages demonstrating ICT integration in the Australian curriculum (ttf.edu.au), and developing a National Support Network (NSN) to facilitate treatment of ICT in teacher education. The third component funded a full-time person with experience in K-12 classroom integration of ICT and a half-time project manager in each institution for a year of project implementation.

During preparation of the TTF proposal TPACK was identified as a useful conceptualization of pre-service teachers' capabilities for ICT integration. It was adopted as the underlying framework for the TTF project and informed the development of the professional learning packages and the work of the NSN. As a consequence, one aspect of evaluation of the TTF project was focused on changes in pre-service teachers' TPACK. That part of the project was planned and managed by a Research and Evaluation Working Group (REWG) with representation from multiple institutions. The TTF project involved 39 institutions and several thousand pre-service teachers. Tracking changes in TPACK presented logistical challenges and required a valid and reliable instrument capable of being administered online to large numbers of respondents.

Measuring TPACK

Abbitt (2011) located 33 studies that assessed TPACK, including 20 that had been conducted in pre-service teacher programs. Another review found 141 instruments measuring some aspect of TPACK (Koehler, Shin, & Mishra 2011). However, despite this abundance of TPACK-related instruments, there is not yet a widely accepted instrument for measuring TPACK.

A direct measure of teachers' TPACK would be desirable but performance-based measures are impractical for large numbers and self-report measures of capabilities are also problematic (Graham, Cox, & Velasquez 2009). Research has demonstrated that teachers' behaviors are influenced by related levels of confidence (Ertmer & Ottenbreit-Leftwich 2010) that can be reliably assessed using self-report measures. There is reason to expect that teachers with greater confidence for performing TPACK-related behaviors would be more likely to perform such behaviors in their classrooms, making a measure of TPACK confidence potentially useful as an indicator of progress in teacher preparation. TPACK confidence of pre-service teachers at two Australian universities had been audited previously using a *TPACK Confidence Survey* (*TCS*) (Albion, Jamieson-Proctor, & Finger 2010). Analysis found two factors representing respectively enhancing and transforming learning outcomes with alpha reliabilities of 0.94 and 0.86.

The *TCS* was used as the starting point for development of an instrument for use in the TTF project (Jamieson-Proctor et al. 2013). Members of the working group undertook additional analysis of the *TCS* data using Rasch modeling to confirm the characteristics of existing items and generated additional items for all aspects of the TPACK framework. The final instrument comprised 48 statements describing behaviors with ICT in Education and respondents were invited to indicate confidence for performing, and anticipated usefulness of, the behavior using a 7-point scale for each. Half of the items focused on the use of ICT to support teaching (representing TPK and TCK) and the remainder addressed the use of ICT to support student learning (representing the more tightly integrated knowledge characteristic of TPCK). Table 1 displays typical items from the major scales.

Technological Pedagogical Knowledge (TPK)
How confident are you that you have the knowledge, skills and abilities to use ICT to …
Demonstrate knowledge of the range of ICT to engage students
Access, record, manage, and analyze student assessment data
Technological Content Knowledge (TCK)
How confident are you that you have the knowledge, skills and abilities to …
Design learning sequences, lesson plans and assessment that use ICT to develop students' Mathematics knowledge, attitudes and skills
Implement meaningful use of ICT by students in achieving Mathematics curriculum goals
ICT integration - TPCK
How confident are you that you have the knowledge, skills and abilities to support students' use of ICT to …
Demonstrate what they have learned
Integrate different media to create appropriate products

Table 1: Sample items from the core groups in the instrument

The questionnaire was administered online using Qualtrics twice, in May-July (T1, N=12881) and October-November 2011 (T2, N=5809), and data were examined using both factor analysis and Rasch modeling with results confirming acceptable factor structure and measurement properties (Jamieson-Proctor et al. 2013).

Measuring TPACK Outcomes for the TTF project

National results

Responses from the national samples at T1 and T2 were compared using nonparametric (Kruskal-Wallis) tests to determine statistical significance of differences with the threshold probability set at $p < .002$ (Finger et al. 2013). Responses at T2 were significantly more positive for all 24 items for confidence related to using ICT to support teaching and for all 24 items for confidence related to using ICT to support student learning. There were no significant differences between T1 and T2 measures for any of the items measuring expected usefulness of ICT for the same behaviors in support of teaching or student learning. The lowest means recorded for usefulness on both sets of items were greater than the highest means recorded for confidence, suggesting that there may be a 'ceiling effect' allowing insufficient scope for pre-service teachers to register any increase in perceived usefulness of ICT from T1 to T2. In general pre-service teachers appear to have high expectations of the usefulness of ICT for supporting teaching and student learning. The interventions supported by the TTF project appear to have resulted in a significant increase in their confidence in their abilities to perform the relevant behaviors in their classrooms.

Institutional results

The national project provided each participating institution with summaries (as frequency tables) of the full national dataset and the dataset for respondents from the individual institution. Availability of these data enabled calculation of means and standard deviations permitting comparison of data from the regional university with the national data. Table 2 presents results from the national dataset and for the regional university collected at T1. Means were calculated for confidence and usefulness on the groups of items identified as representing TPACK elements. The analysis was conducted on raw data prior to the national analysis described above but it subsequently confirmed the validity of the questionnaires. The means obtained for the regional university at T1 were significantly higher than the national means (Z-test, $p < 0.01$) for five of the six composite measures. Analysis of T2 data did not reveal any significant differences, suggesting that if there had been an increase in scores for the regional university relative to the national results that had occurred prior to or in the initial phase of the TTF.

		National			University					
	Item group	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Z**	**p**	
Confidence										
	TPK	9422	4.01	1.40	508	4.24	1.34	3.72	<.001	*
	TCK	6304	3.81	1.45	390	4.01	1.38	2.70	.003	*
	TPCK	8816	3.99	1.38	486	4.13	1.32	2.41	.008	*
Usefulness										
	TPK	9416	5.15	1.11	508	5.29	1.00	3.04	.001	*
	TCK	6218	5.26	1.06	390	5.32	1.02	1.07	.142	
	TPCK	8809	5.11	1.11	485	5.23	1.02	2.45	.007	*

Table 2: Mean scores on subscales for national and university datasets (* = significant at 1%)

Students of the regional university had participated in previous studies that included 20 items from the *TCS* that were included in the TTF instrument (Albion et al. 2010). Thus it was possible to examine longer term trends in responses to those items by comparing data from 2009 and 2010 administrations with data from T1 and T2 collections in the TTF project. Table 3 presents results for those 20 common items from the T1 datasets for the national pool and the regional university together with Z values and probability estimates. Although, as shown in Table 2, the regional university mean on the TPCK subscale is significantly higher than the national mean ($Z = 2.41$, $p = .008$), the means on just 9 of the 20 items are significantly higher ($p < 0.01$).

	How confident are you that you have the knowledge, skills and abilities to support students' use of ICT to …	*National (N = 8816*		*University (N = 486)*				
		M	***SD***	***M***	***SD***	***Z***	***p***	
1	provide motivation for curriculum tasks	4.12	1.32	4.23	1.25	1.98	.024	
2	develop functional competencies in a specified curriculum area	3.82	1.35	3.99	1.31	2.84	.002	*
3	actively construct knowledge that integrates curriculum areas	3.93	1.35	4.07	1.32	2.31	.011	
4	actively construct their own knowledge in collaboration with their peers and others	3.99	1.34	4.07	1.28	1.36	.087	
5	synthesise their knowledge	3.80	1.39	3.93	1.32	2.14	.016	
6	demonstrate what they have learned	4.18	1.34	4.31	1.28	2.22	.013	
7	acquire the knowledge, skills, abilities and attitudes to deal with on-going technological change	4.09	1.41	4.24	1.35	2.29	.011	
8	integrate different media to create appropriate products	3.87	1.43	4.00	1.38	2.04	.021	
9	develop deep understanding about a topic of interest relevant to the curriculum area/s being studied	4.07	1.32	4.17	1.30	1.70	.045	
10	support elements of the learning process	4.05	1.32	4.20	1.27	2.57	.005	*
11	develop understanding of the world	4.23	1.31	4.36	1.22	2.28	.011	
12	plan and/or manage curriculum projects	4.03	1.37	4.20	1.32	2.74	.003	*
13	engage in sustained involvement with curriculum activities	3.98	1.36	4.17	1.33	3.04	.001	*
14	undertake formative and/or summative assessment	3.97	1.42	4.16	1.37	2.87	.002	*
15	engage in independent learning through access to education at a time, place and pace of their own choosing	4.06	1.41	4.26	1.36	3.06	.001	*
16	gain intercultural understanding	3.87	1.37	4.03	1.32	2.42	.008	*
17	acquire awareness of the global implications of ICT-based technologies on society	3.81	1.40	3.93	1.34	1.84	.033	
18	communicate with others locally and globally	4.34	1.38	4.50	1.27	2.62	.004	*
19	understand and participate in the changing knowledge economy	3.79	1.45	4.05	1.35	4.09	<.001	*
20	critically evaluate their own and society's values	3.90	1.39	4.01	1.33	1.68	.046	

Table 3: National and regional university T1 results for selected TPCK subscale items (* = significant at 1%)

The 2009 and 2010 questionnaires used a 4-point scale scored from 1 to 4 with anchors of 'No confidence', 'Some confidence', 'Confident', and 'Very confident' but, as described above, the TTF questionnaire used a 7-point scale, necessitating conversion. Table 4 aligns the 4-point and 7-point scales to show how the 2011 data were converted to the 4-point scale.

2011 National scale	Not confident			Moderately confident			Extremely confident
	0	1	2	3	4	5	6
2009-10 University scale	1	1.5	2	2.5	3	3.5	4
	No confidence		Some confidence		Confident		Very confident

Table 4: Conversion of 7-point scale to 4-point scale for comparison

Table 5 compares results for the 20 common questions across administrations at the regional university in 2009, 2010 and T1 and T2 in 2011. Average scores are included at the end of the table and Z scores and P values are presented for the 2009 to T2 (2011) comparisons. There were no significant differences between scores recorded in 2009 and 2010 or between T1 and T2. Scores on all items were significantly higher ($p < 0.01$) for either T1 or T2 in 2011 than in 2009 or 2010.

	How confident are you that you have the knowledge, skills and abilities to support students' use of ICT to …	*2009 (N = 136)*		*2010 (N = 450)*		*2011 T! (N = 488)*		*2011 T2 (N = 311)*		*2011 T2 - 2009*		
		M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***Z***	***P***	
1	provide motivation for curriculum tasks	2.94	.70	2.93	.73	3.11	.62	3.15	.66	2.92	.002	*
2	develop functional competencies in a specified curriculum area	2.76	.75	2.76	.75	3.00	.66	3.04	.68	3.71	<.001	*
3	actively construct knowledge that integrates curriculum areas	2.86	.74	2.79	.76	3.03	.66	3.08	.67	3.00	.001	*
4	actively construct their own knowledge in collaboration with their peers and others	2.88	.69	2.86	.75	3.04	.64	3.10	.66	3.17	.001	*
5	synthesise their knowledge	2.86	.73	2.78	.74	2.96	.66	3.04	.69	2.39	.008	*
6	demonstrate what they have learned	3.04	.66	2.94	.74	3.15	.64	3.17	.69	1.92	.028	
7	acquire the knowledge, skills, abilities and attitudes to deal with on-going technological change	2.72	.77	2.76	.79	3.12	.67	3.13	.69	5.33	<.001	*
8	integrate different media to create appropriate products	2.63	.87	2.71	.83	3.00	.69	3.02	.73	4.51	<.001	*
9	develop deep understanding about a topic of interest relevant to the curriculum area/s being studied	2.90	.76	2.86	.75	3.09	.65	3.10	.69	2.56	.005	*
10	support elements of the learning process	2.93	.69	2.90	.72	3.10	.63	3.11	.65	2.59	.005	*
11	develop understanding of the world	2.75	.75	2.74	.78	3.18	.61	3.17	.65	5.57	<.001	*
12	plan and/or manage curriculum projects	2.88	.72	2.82	.76	3.10	.66	3.08	.69	2.76	.003	*
13	engage in sustained involvement with curriculum activities	2.81	.74	2.79	.76	3.08	.66	3.08	.68	3.58	<.001	*
14	undertake formative and/or summative assessment	2.96	.71	2.91	.8	3.08	.69	3.11	.69	2.01	.022	
15	engage in independent learning through access to education at a time, place and pace of their own choosing	2.87	.76	2.82	.75	3.13	.68	3.10	.68	3.07	.001	*
16	gain intercultural understanding	2.81	.77	2.81	.76	3.01	.66	3.04	.67	3.04	.001	*
17	acquire awareness of the global implications of ICT-based technologies on society	2.60	.82	2.61	.80	2.97	.67	2.98	.69	4.75	<.001	*
18	communicate with others locally and globally	3.09	.73	3.02	.74	3.25	.64	3.24	.69	2.00	.023	
19	understand and participate in the changing knowledge economy	2.66	.76	2.66	.79	3.03	.67	2.98	.69	4.19	<.001	*
20	critically evaluate their own and society's values	2.75	.74	2.76	.77	3.01	.67	3.01	.69	3.42	<.001	*
	Mean score	2.84	.74	2.81	.76	3.07	.66	3.09	.68	3.36	<.001	*

Table 5: Trends in regional university scores for common TPCK items across 2009-2011 (* = significant at 1%)

Discussion

The elapsed time between the T1 and T2 data collections in 2011 was short but the evidence presented here and elsewhere (Finger et al. 2013) suggests that it may have been sufficient for the actions initiated in the participating institutions to have a positive effect on the TPACK confidence of pre-service teachers. Provided that the momentum for systematic change of teacher preparation programs generated by the TTF can be maintained there is reason to hope that the short but intense intervention of the TTF may have initiated lasting change in teacher preparation with benefits flowing to the enhanced integration of ICT in K-12 classrooms.

For the regional university at which this study was conducted, an unexpected aspect of the data was that the scores at T1 were significantly higher than the national means. By T2 there was no significant difference, suggesting that gains, equivalent to those experienced nationally between T1 and T2, had occurred earlier at the regional university. This observation prompts questions about why TPACK confidence scores at the regional university might have been higher than the national mean at T1.

Table 5 presented data for final year students in 2009 and for students across all years in 2010 and 2011. Although there was no significant increase from 2009 to 2010 there were significant increases on all items from 2010 to 2011 T1. Examination of data for final year students reveals that there are 6 items with significant ($p < .01$) increases from 2009 to 2010 and 2 with significant increases from 2010 to 2011 T1. However, all 20 items show significant increases ($p < .01$) from 2009 to 2011 T1. The implication is that the mean TPCK confidence of students at the regional university has increased from 2009 to 2011 T1 and then plateaued.

In considering potential reasons for these results, two possible explanations emerge. The first is associated with the introduction from 2010 of an *ICT and Pedagogy* course, as a requirement for all students in the Bachelor of Education (BEd) programs. The second is the transition, beginning in 2009, to offering all courses in the BEd online.

For the decade prior to 2000 the BEd programs had included a required course intended to develop computer skills but without a specific focus on the integration of ICT in learning and teaching. A program redesign in 2000 replaced that required course with one intended to develop computer skills with a clear focus on their application for learning and teaching. A subsequent program revision in 2003 removed the required ICT course with the expectation that the 'digital natives' then entering the program had the necessary ICT skills and that educational applications would be integrated across all courses in the program. By 2007 there was ample evidence that the integrated approach was not as successful as had been expected by the program designers. A further program revision reintroduced an *ICT and Pedagogy* course required for all BEd students and taken by most in the third year of their four year program. Final year students responding to the 2011 questionnaire had completed that course. It seems likely that at least some of the increase in TPACK confidence between 2009, when respondents had not taken that course, and 2011, when they had, should be attributable to the contribution of that course, which specifically addressed many of the aspects polled in the TCS. The evidence suggests that the inclusion of the required *ICT and Pedagogy* course was justified and that the course should be maintained.

The program revision initiated in 2007 included a decision that all BEd courses should be available online as well as being taught face-to-face on each of the three campuses where the program is offered. Offering courses online was intended to open access to the program for students who lived distant from the university and whose life circumstances prevented them from moving to a campus for study. It also offered flexibility for students who were studying on a campus when the number requiring a course on their campus was too small to sustain a class or they were unable to attend class for some other reason. Within a year of online offers being initiated, up to 70% of students in any course were studying online and most students were taking at least some courses online. The online offering has affected the way that courses are developed and taught such that all students in a course, even those enrolled on a campus, will interact with at least parts of the online course materials. In doing so they experience learning with ICT in ways that they might not have done in conventionally offered courses and that experience is likely to affect their knowledge of learning and teaching with ICT and their confidence for working with ICT. At the same time, course staff who had to engage with ICT as courses went online have become more confident in their use of ICT to support learning and teaching and more likely to integrate ICT in their face-to-face classes as well as when working online. In doing so they necessarily model the continuous professional learning that will be needed by the graduates they are preparing. The combination of working more extensively with ICT for their own learning, seeing its use modeled more frequently in teaching, and observing the continuing professional learning of more senior educators will have contributed to the increased scores of pre-service teachers on the TPACK confidence scales.

Probably the key lesson for teacher preparation from these data is the importance of programs 'practising what they preach' by modeling the use of ICT to support learning and teaching in ways similar to those being promoted for classroom use. ICT continues to develop rapidly and regardless of how rich an experience of learning with ICT pre-service teachers have had in their own education they will be expected to return to schools prepared to make effective use of a new generation of ICT. The challenge for relatively short programs of teacher preparation to change expectations developed through twelve years of prior educational experience (Belland 2009) continues but

the data presented here suggest that progress can be made when teacher educators are challenged and supported to engage with new ICT in their work. In that way pre-service teachers can both experience new ICT for their own learning and see modeled the process of continuous professional learning and program renewal.

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.

AICTEC. (2009). Digital Education Revolution Implementation Roadmap. Retrieved from http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/Documents/AICTEC_DER_ROADMAPAdvice.pdf

Albion, P. R., & Ertmer, P. A. (2002). Beyond foundations: The role of vision and belief in teachers' preparation for integration of technology. *TechTrends, 46*(5), 34-38.

Albion, P. R., Jamieson-Proctor, R., & Finger, G. (2010). Auditing the TPACK Confidence of Australian Pre-Service Teachers: The TPACK Confidence Survey (TCS). In C. Maddux, D. Gibson & B. Dodge (Eds.), *Research Highlights in Technology and Teacher Education 2010* (pp. 303-312). Chesapeake, VA: Society for Information Technology in Teacher Education.

Barber, M., & Mourshed, M. (2007). How the world's best-performing schools come out on top. London: McKinsey & Company. Retrieved from http://www.mckinsey.com/locations/UK_Ireland/~/media/Reports/UKI/Education_report.ashx

Belland, B. R. (2009). Using the theory of habitus to move beyond the study of barriers to technology integration. *Computers & Education, 52*(2), 353-364. doi: 10.1016/j.compedu.2008.09.004

Cuban, L. (2001). *Oversold and underused: computers in the classroom*. Cambridge: Harvard University Press.

DEEWR. (2008). Success through partnership: Achieving a national vision for ICT in schools. Retrieved from http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/Documents/DERStrategicPlan.pdf

DEEWR. (2010). ICT Innovation Fund Guidelines 2010 – 2012. Retrieved from http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/DigitalStrategyforTeachers/Documents/ICTInnovationGuidelines.pdf

Ertmer, P. A. (1999). Addressing First- and Second-Order Barriers to Change: Strategies for Technology Integration. *Educational Technology Research and Development, 47*(4), 47-61.

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

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher Technology Change: How Knowledge, Confidence, Beliefs, and Culture Intersect. *Journal of Research on Technology in Education, 42*(3), 255-284.

Finger, G., Albion, P., Jamieson-Proctor, R., Cavanagh, R., Grimbeek, P., Lloyd, M., et al. (2013). Teaching Teachers for the Future (TTF) Project TPACK Survey: Summary of the Key Findings. *Australian Educational Computing, 27*(3), 13-25.

Graham, C., Cox, S., & Velasquez, A. (2009). *Teaching and Measuring TPACK Development in Two Preservice Teacher Preparation Programs*. Paper presented at the Society for Information Technology and Teacher Education International Conference 2009, Charleston, SC, USA.

Jamieson-Proctor, R., Albion, P., Finger, G., Cavanagh, R., Fitzgerald, R., Bond, T., et al. (2013). Development of the TTF TPACK Survey Instrument. *Australian Educational Computing, 27*(3), 26-35.

Koehler, M. J., Shin, T. S., & Mishra, P. (2011). How Do We Measure TPACK? Let Me Count the Ways. In R. N. Ronau, C. R. Rakes & M. L. Niess (Eds.), *Educational Technology, Teacher Knowledge, and Classroom Impact: A Research Handbook on Frameworks and Approaches* (pp. 16-31). Hershey, PA: Information Science Reference.

MCEECDYA. (2008). *Joint Ministerial Statement on Information and Communications Technologies in Australian Education and Training: 2008-2011*. Retrieved from http://mceecdya.edu.au/verve/_resources/AICTEC_JMS_on_ICT_in_Aust_Ed_and_Training.pdf

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*, 1017-1054.

Mishra, P., & Koehler, M. J. (2007). *Technological Pedagogical Content Knowledge (TPCK): Confronting the Wicked Problems of Teaching with Technology*. Paper presented at the Society for Information Technology and Teacher Education International Conference 2007, San Antonio, Texas, USA.

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

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