HOW PREPARED ARE OUR PRE-SERVICE TEACHERS TO INTEGRATE TECHNOLOGY? A PILOT STUDY

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Abstract

This study examines pre-service teachers' technological, pedagogical and content knowledge and the relationships between the factors influencing the development of this knowledge. It concludes with a discussion about the major implications of these findings for the improvement of pre-service teacher education courses. The participants were pre-service students enrolled in teacher education programs in one Australian university in 2011. The findings suggest that more needs to be done to prepare pre-service teachers to use technology. Learning opportunities need to be created to develop students' personal levels of ICT proficiency and make explicit connections to the expectations of teachers described in the Australian Curriculum and the National Professional Standards for Teachers (Graduate Level).

In 2011 following the challenge of compulsory curriculum renewal and involvement in the Teaching Teachers for the Future (TTF) Project, Seaview University (pseudonym) began the process of evaluating the implementation of their new pre-service education courses to ensure these were aligned with the Australian Curriculum (ACARA, 2010) and the National Professional Standards for Teachers (NPST) at the Graduate Level (AITSL, 2011). Specifically, there was a need for pre-service teachers to be able to:

- Implement teaching strategies for using ICT to expand curriculum learning opportunities for students (Focus Area 2.6);
- Demonstrate knowledge of a range of resources, including ICT, that engage students in their learning (Focus Area 3.4);
- Demonstrate an understanding of the relevant issues and the strategies available to support the safe, responsible and ethical use of ICT in learning and teaching (Focus Area, 4.5) (AITSL, 2011).

As a result, there was an interest in investigating our pre-service teachers' existing knowledge, perceptions, access to, and experiences using, technology to support their learning and teaching. The study involved surveying students to establish baseline data as a leading indicator of students' learning with technology (Lyddon & McComb, 2008). This could be used to evaluate the impact of changes made to the design of topics (also referred to as subjects or courses in some institutions). This study was conducted independently of the TTF Project and involved all students in the School of Education at Seaview University across all topics.

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Background

Effective integration of technology in teaching depends largely on teachers' skills and capabilities (Veen, 1993) and can have a positive impact on student learning in schools only when teachers know how to use it to promote student thinking, expression, and knowledge building (Loveless & Dore, 2002). Questions continue to emerge about whether teachers are adequately prepared to integrate

technology in their classrooms (Polly, Mims, Shepherd, & Inan, 2010). Pre-service teacher preparation plays a pivotal role in determining the future role of technology in education (Wedman & Diggs,

2001; Wheeler, 2001) and has been described as "the single most important step" (Culp, Honey, & Mandinach, 2003, p. 12). One of the difficulties facing teacher educators is that, although the true measure of their success is in the work which will be done by teachers some years in the future, decisions about the design of courses must be made in the present (Albion, 1999). The prevailing paradigm of technology education in teacher preparation has a primary focus on teaching pre-service teachers how to use various computer applications (Angeli & Valanides, 2005). However, this approach has not translated into increased or better quality integration of technology into teaching (Oliver & Shapiro, 1993).

Mishra and Koehler (2006) have advocated a conceptual framework in teacher education that brings together teachers' content knowledge, pedagogical knowledge and technological knowledge, focusing on the interactions between these three domains. This is known as the Technological Pedagogical Content Knowledge (TPACK) model. The model 'attempts to capture some of the essential qualities of teacher knowledge required for technology integration in teaching, while addressing the complex, multifaceted, and situated nature of this knowledge' (Mishra & Koeher, 2006, p. 1017). Specifically, it attempts to highlight connections and interactions between pedagogical, technological and content knowledge. Thus, rather than view technology as an 'add-on" to the existing suite of classroom practices, there is a need to rethink pre-service education with increased emphasis on authentic problem solving and design-based projects (Girod, Bell, & Mishra, 2007; Koehler & Mishra, 2009). As argued by Albion (1999), decisions about the structure and content of teacher education courses should be based upon an understanding of the factors that contribute to successful technology integration. 'An appreciation of those factors should permit their development to be traced and the design of courses to be adjusted to achieve the desired outcomes' (p. 2).

Method

There are three key research questions for this study. These are:

1. To what extent does pre-service teachers' knowledge of technology, content and pedagogy and the interactions between these (e.g. TPACK scores) increase with years completed within their degrees?
2. What factors are associated with the development of pre-service teachers' technological pedagogical content knowledge (as well as their interactions e.g. TPACK scores).
3. What are the implications of the survey data for program design and accreditation based on the Australian National Professional Standards for Teachers (Graduate Level)?

Participants were 255 pre-service students (192 Female) enrolled in teacher education programs in an Australian university in 2011. Programs included students undertaking a 4-year Bachelor of Education degree in Early Childhood, Primary, Middle School / Secondary or Special Education. Predominantly, students were full-time students (n = 233). 13 students were enrolled in 2-year Master of Teaching courses, while all other students were enrolled in 4-year Bachelor's degrees. The majority of students (164) were undertaking a degree in Primary or Middle School / Secondary. The mean age of participants was 26 years (*SD* = 8 years). 50 students were in their first year, 35 in their second year, 123 in their third year and 46 in their fourth year (1 non-response).

Data was collected via an online survey administered in October 2011. At the time of this survey, students had a diverse range of professional experience in classrooms from none (for part-time first year students), to up to 80 days for final year students about to graduate. The survey was piloted with three, pre-service teachers enrolled in the same school of education. The main goal of the pilot was to test the appropriateness of the survey items, identify any misunderstandings in the language and check the time required to complete the survey. Based on feedback, no revisions were made.

The survey contained questions about demographic information, the TPACK scale consisting of a series of 7-point Likert scale questions on technology, pedagogy, content knowledge and their interactions (Koh, Chai & Tsai, 2010), student perspectives on teaching and learning, technology proficiency and access questions, and several open ended questions (Kennedy, Judd, Churchward,

Gray, & Krause, 2008; Moyle & Owen, 2009). The participants for this study had diverse curriculum specialisations ranging from generalist early childhood and primary to special education (primary and secondary) and secondary Mathematics, Health, Physical Education, Science (biology, physics chemistry, earth science), Languages (Spanish, French, Italian, Japanese, Chinese, Indonesian, German and Greek), History, Geography, Legal Studies, Politics, Women's Studies, Visual Arts, Information Technology and English. Therefore, the survey by Koh et al, (2010) was chosen as it catered for the study participants' profiles.

Specifically, this survey instrument was chosen because it catered for pre-service teachers with diverse subject specialisations. The survey instrument was been developed by an expert committee composed of five faculty members specializing in ICT education based on the Survey of Preservice Teachers' Knowledge of Teaching and Technology developed by Schmidt et al. (2009). Koh et al (2010) concluded the changes they made to include additional curriculum areas into the design of the survey items could be achieved 'without substantial changes to survey items' (p. 566). The questions were made more generic in this study. For example, 'I have sufficient knowledge about my Curriculum Subject 1' was changed to 'I have sufficient knowledge about the curriculum learning areas relevant to my course'. In this study, six questions that were not relevant were removed. Five of these questions related to a second curriculum specialisation which did not apply to early childhood and primary programs. The sixth question removed, referred to content knowledge. All other questions designed to measure technological knowledge (TK), knowledge of pedagogy (PK), knowledge of teaching with technology (TPK, TCK and TPACK) were retained. The amended scale reliabilities are reported in the results. Finally, the survey asked participants to indicate on a five point scale (*1, not at all - 5, exclusive access*), their level of access to mobile computing technologies, specifically mobile phones, smart phones, laptop computers and iPad's.

Data Analysis and Results

Items were averaged to create five domains, Pedagogical Knowledge (PK, $\alpha = .91$), Technological Knowledge (TK $\alpha = .92$), Technological Pedagogical Knowledge (TPK, $\alpha = .91$) Content Knowledge (CK $\alpha = .87$) and Technological, Pedagogical and Content Knowledge (TPACK, $\alpha = .93$). These data were analysed using One-Way Analyses of Variance and Bonferroni post-hoc analyses. For all comparisons, an alpha level of .05 was used to determine significance. The amended scales displayed good reliability.

A One Way Analysis of Variance (ANOVA) revealed a significant effect of year level on Pedagogical Knowledge (PK), $F(3, 200) = 4.75$, $p = .003$. Bonferroni post hoc analyses ($p = .05$) revealed this was characterised by a significant difference between 1st ($M = 4.6$, $SD = 1.5$) and 4th year levels ($M = 5.5$, $SD = 0.97$), as well as 2nd ($M = 4.7$ $SD = 1.4$) and 4th year levels, $ps < .05$. No other comparisons were significantly different.

Technological Knowledge did not significantly differ between year levels ($F = 1.3$, $p = .26$). It is worth noting that average TK scores were only 4.4 ($SD = 1.4$), indicating only moderate levels of technological understanding amongst students.

Technological Pedagogical Knowledge was significantly affected by year level, $F(3, 198) = 3.29$, $p = .022$, specifically, with an increase between second ($M = 4.1$, $SD = 1.5$) and third year levels ($M = 4.9$, $SD = 1.2$), $p < .05$.

Content Knowledge increased significantly across year levels, $F(3, 200) = 8.34$, $p < .001$, characterised by increases from 1st to 3rd years, 1st to 4th years, 2nd to third years, and 2nd to 4th years, $ps < .05$. Descriptive scores are available in Table 1.

TPACK scores were found to significantly increase across year levels, $F(3, 199) = 4.07$, $p = .008$. This was characterised by a significant increase from 1st ($M = 4.1$, $SD = 1.5$) to 3rd year levels ($M = 4.9$, $SD = 1.2$), $ps < .05$.

Table 1. Descriptive scores for Content Knowledge by year level (Standard Deviations in Brackets)

Year	Average Content Knowledge Score (Standard Deviation)
1st	3.9 (1.6)
2nd	4.1 (1.6)
3rd	4.9 (1.2)
4th	5.3 (1.2)

TK, PK and CK scores were all significantly correlated (Table 2), suggesting that the TPACK instrument is likely not tapping multiple knowledge domains but overlapping domains.

Table 2. TPACK inter-scale correlations. * Denotes Significance at the $p < .01$ level

	PK	TK	TPK	CK	TPACK
PK	1	.522*	.690*	.820*	.721*
TK	.522*	1	.806*	.577*	.826*
TPK	.690*	.806*	1	.662*	.900*
CK	.820*	.577*	.662*	1	.743*
TPACK	.721*	.826*	.900*	.743*	1

A marginal gender difference was observed in the Technological Knowledge domain, with males (M = 4.7, SD = 1.4) self-reporting as being more technologically knowledgeable than females (M = 4.3, SD = 1.4), $t(199) = 1.81$, $p = .072$.

Access to mobile computing equipment was negatively related to students self rated scores on the TPACK scales. Specifically, access to laptops was negatively related to students Pedagogical Knowledge (r = -.172, p = .015) and Content Knowledge scores (r = -.168, p = .017). Greater access to iPad technology was associated with lower PK (r = -.159, p = .025), TPK (r = -.155, p = .030), CK (r = -.131, p = .050) and TPACK scores (r = -.161, p = .023). Access to Mp3 players with video capability was associated with greater PK (r = .184, p = .009), TK (r = 314, p < .001), TPK (r = .232, p = .001), CK (r = .146, p = .038) and TPACK (r = .235, p = .001) scores.

Discussion

The results indicate that there is a significant increase in all domains of the TPACK across the undergraduate degrees. Students were generally increasing in their domain specific understandings, and integrating these into an overall increase in TPACK scores across their degree. Content knowledge and pedagogical knowledge showed the most marked increase, with students increasing from below the midpoint in first year to, on average, above five in the final year of their degree.

The finding that students' technological pedagogical knowledge was significantly affected by year level, with an increase between second and third year levels may be the result of the introduction of the new Numeracy and ICT topics during the third-year of the 4-year Primary and Middle School / Secondary degree programs. In particular, the version of the topic delivered in the Primary degree program included introducing students to the TPACK model and required students to use a variety of tools (such as flip-cameras, IWB software, web 2.0 tools, learning objects, eportfolios and ipods) as part of learning activities and assessment tasks. In particular, students explored these tools as learners themselves and investigated how they could be used to support them as teachers using appropriate pedagogies. Due to the broad focus of the numeracy and ICT topics in the Primary and Middle School / Secondary degrees on both the Australian Curriculum and the South Australian Curriculum Standards and Accountability Framework (SACSA), it is not surprising that there was not a corresponding substantial increase in students' technological content knowledge. This may have been

because students' found it difficult to understand where technological pedagogical knowledge intersected with curriculum content that was either not yet written (in the case of the Australian Curriculum), or outdated (in the case of SACSA that was implemented in 2001).

Technological knowledge was not found to increase across the course of students' degrees, and overall, TK scores were around the midpoint. This may be indicative that education courses are not adequately training students as to the variety of technology available to them. This makes sense, as training students in pedagogy and content has been a priority for education courses at this institution. However, as technology continues to become more prolific, it will continue to infiltrate classrooms irrespective of whether teachers understand it, or can effectively use it. Therefore, it is critical that pre-service teachers receive explicit teaching about what technology is available in the course of their degree, and strategies for how to stay abreast of new technological developments. There are also financial and equity issues as there are limited funds available to provide students with access to mobile devices typically available in schools. Therefore, 'bring-your-own-device' models are being investigated however, not all students have the income to purchase these, especially if they are not yet fully integrated into degree programs.

While TPACK scores were found to increase from first to fourth year levels, the final scores were still relatively low relative to the midpoint. This implies that more work is needed to effectively raise the level of knowledge about the interactions between technological pedagogical and content knowledge. As an amalgam of the other domains, one critical target for this is the increase in technological knowledge.

Males reported having more technological knowledge than females. This may indicate a genuine gender difference in technology use, or a response bias, wherein males profess to know more about technology (without objectively knowing more). Either way, this result may indicate a critical difference between the way the genders interact with technology in the current cultural context. The finding that males consider themselves more knowledgeable in this domain than females has several important implications. First, if this is a genuine difference, cross-gendered partnership assignments may aid in the development of technological knowledge in females. Second, males may be more confident in attempting to use technology, and therefore aid in a 'give it a go culture'. Thirdly, there may be hesitance for males to accept technological advice from females due to a perception that males are the 'domain experts' (for examples of people being less inclined to take advice from those they perceive as less knowledgeable, see Yaniv, 2004). This may have implications for the teaching of male pre-service teachers about technological principles by female academics.

The high inter-correlations between the fields of knowledge, even those that are conceptually unrelated are concerning. According to TPACK theory (Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2009/10), technological knowledge scores should be unrelated to pedagogical knowledge scores. This was not true in the present data. There may be two reasons for this relationship. First, because the undergraduate teaching program raises students' performance in most of the measured domains simultaneously, a false correlation has been observed. Second, perhaps the TPACK instrument currently taps highly interrelated fields, rather than distinct knowledge areas. Further research is required to determine if the latter is the case, and if so, refine the measurement instrument.

The findings also indicated lower TPACK scores for participants with greater access to mobile computing, particularly iPads. One explanation for this finding could be that students with greater access to mobile computing technology may be more likely to use this technology for non-study related purposes during class, thus reducing their engagement and understanding of pedagogy and content and their interactions with technology. Further research is required to investigate this relationship. Conversely, increased access to Mp3 technology with video functions was generally associated with higher TPACK scores. This may be indicative of these participants' abilities to watch video-replays of lectures and course material 'on-the-go' and/or create their own podcasts and videos as part of assessment tasks.

The findings of this study will be valuable to establish baseline data against which to monitor the

impact of future changes to topics. Given that this was the first time that the new programs were implemented, it is not possible to discuss the findings in terms of differences with previous years. However, as part of the survey, students were invited to identify what they considered to be the most valuable learning experiences that will help them to integrate ICT into their future practice with students. Analysis of these comments indicates that students value opportunities to develop both their personal level of ICT proficiency and connect this with their role as 21st Century teachers. It was clear that there was not one common activity or approach that students identified as being the most valuable although many activities identified were associated with the numeracy and ICT topic for the Primary degree course or previous ICT related activities that are no longer offered following the renewal of all programs.

The implications of students' comments point to the need to provide multiple entry points, support strategies and choice of assignment options for students based on their areas of interest and ICT proficiency. Many students indicated a preference for practical, face-to-face opportunities to 'explore, play and interact' with peers and knowledgeable, approachable tutors who are able to 'lead by example'. Whereas other students indicated that the most valuable learning experiences were being able to work independently to explore online video tutorials and develop lesson plans as part of assessment tasks.

There is a need for all curriculum specialisation topics at Seaview University to integrate ICT to ensure that our students develop the technological pedagogical content knowledge to implement the Australian Curriculum and National Professional Standards for Teachers (Graduate Level). Whilst the numeracy and ICT topics for the Primary and Middle/ School Secondary Programs can contribute to the development of students' TPACK, there is a need to connect the use of ICT as a General Capability to specific curriculum content areas relevant to each program. In the near future, there will also be a need to ensure that Primary degree programs address all aspects of the Technologies curriculum and this will require pre-service teachers understanding the differences between ICT as a General Capability and the Digital Technologies curriculum.

Conclusion

This study investigated three key research questions in context of Seaview University. In response to these, it is evident that there is a significant increase in all domains of the TPACK as students move through each year of their degree program. Content knowledge and pedagogical knowledge showed the most marked increase. Although TPACK scores increased from first to fourth year levels, the final scores were still relatively low. Technological knowledge was not found to increase across the course of students' degrees. The findings suggest that it is critical for pre-service teachers to receive explicit instruction about what technology is available to them especially within curriculum specialisation topics. It is clear that more needs to be done at Seaview University to prepare pre-service teachers to use technology. Learning opportunities need to be created to develop students' personal levels of ICT proficiency and make explicit connections of the expectations of teachers described in the Australian Curriculum and the National Professional Standards for Teachers (Graduate Level).

References

ACARA. (2010). Australian curriculum online. Retrieved 29th September, 2011, from http://www.australiancurriculum.edu.au/Home

AITSL. (2011). National professional standards for teachers. Retrieved 29th September, 2011, from http://www.teacherstandards.aitsl.edu.au/

Albion, P. (1999). Self-efficacy beliefs as an indicator of teachers' preparedness for teaching with technology, International Conference of the Society for Information Technology & Teacher Education (SITE). San Antonio, TX, United States: Association for the Advancement of Computing in Education (AACE).

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

Culp, K., Honey, M., & Mandinach, E. (2003). A retrospective on twenty years of education technology policy. Retrieved 30th September, 2011, from http://www2.ed.gov/rschstat/eval/tech/20years.pdf

Girod, M., Bell, J. , & Mishra, P. (2007). Using digital video to re-think teaching practices *Journal of Computing in Teaching Education*, 24(1).

Kennedy, G., Judd, T., Churchward, A., Gray, K., & Krause, K. (2008). First year students' experiences with technology: Are they really digital natives? Australasian Journal of Educational Technology, 24(1), pp. 108-122.

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, 9(1), pp. 60-70.

Koh, J., Chai, C., & Tsai, C. (2010). Examining the technological pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. *Journal of Computer Assisted Learning*, 26, pp. 563-573.

Loveless, A., & Dore, B. (Eds.). (2002). ICT in the primary school. Buckingham, U.K. Open University Press.

Lyddon, J., & McComb, B. (2008). Strategic reporting tool: Balanced scorecards in higher education. *Journal of Applied Research in the Community College,* 15(2), 163-170.

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

Moyle, K., & Owen, S. (2009). Listening to students' and educators' voices: The views of students and early career educators about learning with technologies in Australian education and training. Canberra.

Oliver, T., & Shapiro, F. (1993). Self-efficacy and computers. *Journal of Computer-Based Instruction*, 20(3), pp. 81-85.

Polly, D., Mims, C., Shepherd, C., & Inan, F. (2010). Evidence of impact: Transforming teacher education with preparing tomorrow's teachers to teach with technology (pt3) grants. *Teaching and Teacher Education*, 26(4), pp. 863-870.

Schmidt, D., Baran, E., Thompson, A., Mishra, P., Koehler & Shin, T. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for pre-service teachers. Journal of Research on Teaching in Education, 42(2), pp. 123-149.

Veen, W. (1993). The role of beliefs in the use of information technology: Implications for teacher education, or teaching the right thing at the right time. *Journal of Information Technology for Teacher Education*, 2, pp. 139-153.

Wedman, J., & Diggs, L. (2001). Identifying barriers to technology-enhanced learning environments in teacher education. *Computers in Human Behavior* 17, pp. 421–430.

Yaniv, I. (2004). Receiving other people's advice: Influence and benefit. *Organizational Behavior and Human Decision Processes, 93*, 1-13.

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