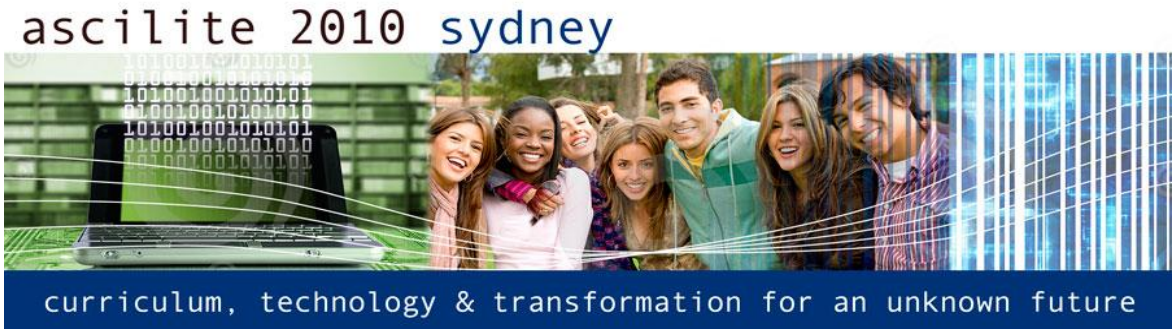

Impact of a new curriculum on pre-service teachers' Technical, Pedagogical and Content Knowledge (TPACK)

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This paper reports some preliminary findings of a formative evaluation on the impact of a new curriculum on pre-service teachers' technical, pedagogical and content knowledge (TPACK). It discusses the design principles employed and its implementation process. A survey adapted from Schmidt et al. (2009) was administered at the beginning and completion of the course. The post-course survey showed increase in pre-service teachers' self-reported ratings in technology, pedagogy and content knowledge. Implications are discussed.

Key words: teacher education, course evaluation, curriculum design, educational technology, pedagogy, technology training, technological pedagogical content knowledge (TPACK)

Introduction

Since Mishra and Koehler (2006) articulated the concept of *technological pedagogical content knowledge*, also known as *technology, pedagogy and content knowledge* (TPACK), there has been an emerging body of literature reiterating the importance of TPACK. This paper reports a teacher education program's effort in applying the principle of TPACK to the design of its pre-service ICT course, and preliminary findings of a formative evaluation investigating its impact on per-service teachers' TPACK.

Theoretical framework

TPACK is an extension of pedagogical content knowledge (Shulman, 1986). While pedagogical content knowledge focuses on the development of understanding of how students learn specific content areas – their perceptions of the content being learned, common misconceptions that they have about the content, and teaching approaches that can maximize students learning; TPACK focuses on the "the connections, interactions, affordances, and constraints between and among content, pedagogy, and technology" (Mishra & Koehler, 2006, p. 1025).

TPACK emphasizes a teacher's understanding of how technologies, particularly information and communication technology (ICT), can be used effectively as a pedagogical tool (Koehler & Mishra, 2006). As shown in Figure 1, TPACK converges complex interplay of three bodies of knowledge: (1) *pedagogical content knowledge* (Shulman, 1986), (2) *technological content knowledge* (knowing what kind of technology tools is available for teaching what), and (3) *technology pedagogical knowledge* (able to choose an ICT tool based on its affordances to address a particular teaching/learning need). To develop TPACK, teachers not only need to know how to use computer and software, but also be aware of the strategies to incorporate ICT tools to enhance student understanding of a particular subject's content.

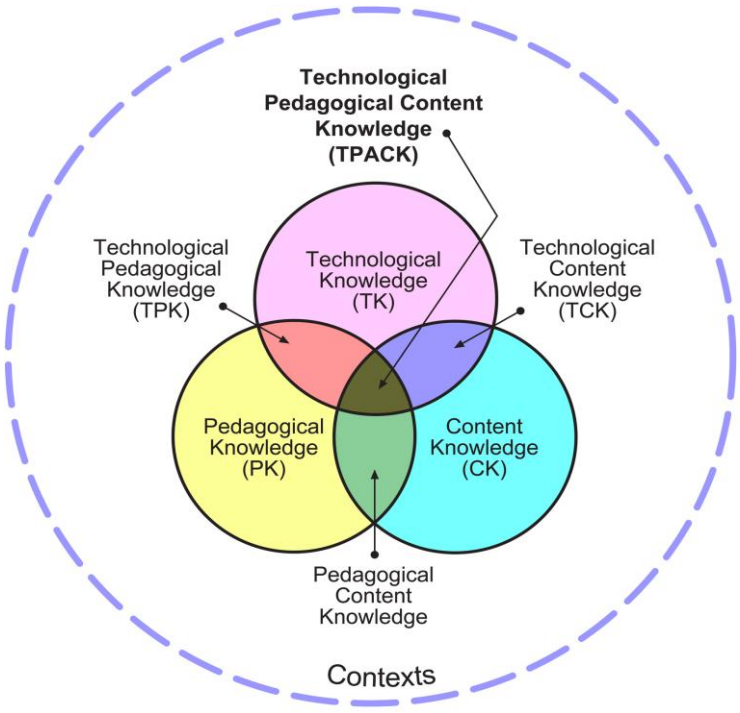

Figure 1: Koehler & Mishra (2009) The TPACK framework and its knowledge components

Context and method

A fatal problem with traditional pre-service teacher ICT training is that oftentimes technology is nominated as an answer to the problem which is unknown (Guri-Rosenblit, 2005). Prior to 2009, Information Technology in Education, a 20-hour compulsory course for Master of Teaching students (MTeach hereafter), at the University of Sydney focused on the development of the technical skills that were presumably needed by pre-service teachers. MTeach is a post-graduate entry teacher preparation program. While the program attracts many new university graduates, about 30% of MTeach students are over 30 years of age, most of whom have worked in a wide range of professions prior to the enrolment in the program. Varied demographics and technical skills possessed by MTeach students make a one-size-fit-all model problematic. Further, this curriculum failed to reflect the latest developments at both national level and the local educational systems (i.e. the Australian federal government's Digital Education Revolution initiative). Opportunities came in 2009 when we were able to re-design and implement a new curriculum that would depart from the skill-oriented training, and to shift the emphasis to the development of pre-service teachers' technology, pedagogy, and content knowledge (Mishra & Koehler, 2006).

The new curriculum design attempted to adhere to four principles: (1) learning tasks are problem-centred (Merrill, 2002), (2) skills are developed via learning-technology-by-design approach (Mishra & Koehler, 2006), (3) design tasks are accomplished collaboratively (socio-cultural theory), and (4) learners are encouraged to engage in reflective practice (Schon, 1983). Attempts were made to ensure that each component of TPACK was adequately addressed (Table 1).

Table 1: Activities to Address Each Component of TAPCK

Three Bodies of Knowledge	Activities
Pedagogical content knowledge	Design tasks that require students to connect what they do in the ICT unit to what they have learned in their curriculum subject areas.
Technological content knowledge	Demonstrations of exemplar teaching/learning resources (of different subject areas) produced by using different software applications.
Technology pedagogical knowledge	Design tasks in which students worked in pairs exploring the affordances of the ICT tools of their choice to address a particular teaching/learning need.

The design tasks were carried out via two separate activities: (1) to design and create an Interactive Whiteboard teaching/learning resource and (2) to design a multimedia teaching/learning resource. Both design tasks require pre-service teachers to address a particular teaching/learning need which is difficult for teachers to teach and for students to learn in traditional classrooms. In order to accomplish the design tasks, pre-service teachers would need first to get themselves familiar with the school curriculum. They then identified a specific topic or concept that they believed to be difficult for teachers to teach and for students to learn. Once a specific topic was chosen, trainee teachers explored which ICT tool(s) could address this need.

When the new curriculum was first implemented in 2009, everyone in the program was required to use the same software program (Marvin http://www.marvin.com.au/) to complete the second design task. The end of course evaluation showed that this approach failed to accommodate the varied needs of our target population. In Semester 1, 2010, we allowed course participants to make their own software choice for the second design task. The software applications chosen by the students included Microsoft PowerPoint, Excel, web editor, Marvin, and Kahootz (http://www.kahootz.com/kz).

Before trainee teachers started each of their design tasks, we used tutorial sessions showing how to use different features of the software applications in use, and explaining the steps involved in designing and creating a learning resource. During the design process, the tutors discussed with each pair individually on their design ideas and provided comments and suggestions. In Week 10, trainee teachers uploaded the resources that they had created to WebCT for peer review. A peer review list was provided to ensure that each resource was reviewed by at least three peers. Following the peer review, trainee teachers finalized their resources in Week 11. For each design task, trainee teachers were required to write a reflection, documenting their learning experiences and discussing the possibility of transferring such an experience to the classroom contexts.

This paper is based on the preliminary findings on a pre- and post questionnaire administered in the first (pre-course) and last week (post-course) of the 12-week course to answer the question: "To what extent does the new curriculum help improve pre-service teachers' technological pedagogical and content knowledge (TPACK)"? The questionnaire was adapted from the Survey of Pre-service Teachers' Knowledge of Teaching and Technology (Schmidt, Baran, Thompson, Koehler, Mishra & Shin, 2009). It measured prospective teachers' technological knowledge (TK), technological pedagogical knowledge (TPK), Technology Pedagogy and Content Knowledge (TPACK) and pre-service teachers' evaluation of the course. Technological content knowledge (TCK) was intended to be included in the survey, but was unfortunately left out due to unforeseen circumstances. Both pre- and post surveys were administered online. The pre-survey was completed by students outside the class prior to the first tutorial. The post-survey was administered in class at the beginning of the last tutorial.

Two hundreds and sixteen students completed the pre-course questionnaire (75% of 286 enrolled students, 48 male and 168 female). One hundred and seventy-two students completed the post-course survey (69.6% of the 247 enrolment as the result of attrition during the semester, 39 male and 133 female).

Findings and discussion

TPACK emphasizes teachers' understanding of how ICT can be used effectively as a pedagogical tool – the basis of effective teaching with technology (Koehler & Mishra, 2009). The development of TPACK aims at equipping teachers with the knowledge and skills that will enable them to utilize ICT tools to address some of the problems that students face when learning what is difficult for teachers to teach and for students learn. As shown in Table 2, the course seemed to have made a positive impact on trainee teachers' TPACK.

Table 2: Technology, Pedagogy, and Content Knowledge (TPACK)

	Strongly Agree		Agree		N/A		Disagree		Strongly Disagree	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
I can teach lessons that appropriately combine mathematics ICT tools and teaching approaches	2.3%	4.7%	17.6%	62.2%	30.6%	14.5%	42.6%	17.4%	6.9%	1.2%
I can teach lessons that appropriately combine literacy, ICT tools and teaching approaches	0.9%	8.1%	27.8%	68.6%	27.8%	11.0%	38.0%	11.0%	5.6%	1.2%
I can teach lessons that appropriately combine science, ICT tools and teaching approaches	2.3%	5.2%	16.2%	49.4%	32.4%	20.3%	43.1%	22.7%	6.0%	2.3%
I can teach lessons that appropriately combine social studies, ICT tools and teaching approaches	1.4%	5.2%	25.9%	60.5%	28.7%	20.3%	38.0%	12.2%	6.0%	1.7%
I can select ICT tools to use in my classroom that enhance what I teach, how I teach and what students learn	4.2%	9.3%	37.5%	75.0%	23.1%	7.6%	31.9%	7.6%	3.2%	0.6%
I can use strategies that combine content, ICT tools and teaching approaches that I learned about in my coursework in my classroom	2.3%	9.3%	28.7%	73.8%	31.5%	7.6%	33.3%	8.1%	4.2%	1.2%
I can provide leadership in helping others to coordinate	3.2%	9.3%	25.5%	52.9%	22.7%	9.9%	40.3%	23.8%	8.3%	4.1%

the use of content, ICT tools and teaching approaches at my school										
I can choose ICT tools that enhance the content for a lesson	1.9%	10.5%	43.1%	80.2%	22.2%	2.3%	30.1%	6.4%	2.8%	0.6%

Of the eight items, the first four asked prospective teachers' self-rated abilities of teaching lessons that appropriately combine ICT tools and teaching approaches in the teaching of each of the four curriculum subjects, namely Mathematics, Literacy, Science and Social Science. As shown in Table 2, the course seemed to have made a positive impact on trainee teachers' confidence in all of the four curriculum subject areas. The percentages increased by about 47% for who strongly agreed or agreed that they were able to combine ICT tools and pedagogy to the teaching of Mathematics and Literacy. The percentages of "disagree" and "strongly disagree" decreased from 49.5% to 16.8% for Mathematics and from 44.1% to 12.2% for Literacy. In comparison, the percentage changes to the abilities of combine ICT and pedagogy in the teaching of Science and Social Science were less, but still showed an increase of 36.1% for Science and 38.4% for Social Science respectively.

TPACK enables teachers to select appropriate ICT tools to be used in their classrooms to enhance what they teach, how they teach and what students learn. The percentages of pre-service teachers who agreed or strongly agreed that they had such capabilities almost doubled in the post-course survey (84.3% vs. 41.7%). Those who disagreed or strongly disagreed dropped from 35.1% to 8.2%. Those who agreed or strongly agreed, "I can choose ICT tools that enhance the content for a lesson," increased from 45% in the pre-course to 90.7% in the post-course questionnaire.

When asked about their abilities of using strategies that combine content, ICT tools and teaching approaches that they learned about in their classroom, the percentage that chose "agree" or "strongly agree" increased from 31% in the pre-course to 83.1% in the post-course survey; and those who disagreed or strongly disagreed dropped from 37.5% to 9.3%. Those who agreed or strongly agreed that they could "provide leadership in helping others to coordinate the use of content, ICT tools and teaching approaches" at their schools, increased from 28.7% in the pre-course survey to 62.2% in the post-course survey.

The preliminary findings of this study supported previous studies that the TPACK approach helps improve pre-service teachers' confidence and skills in productive technology integration (Doering, Scharber, Miller, & Veletsianos, 2009; So & Kim, 2009). The findings seemed to suggest that the new curriculum helped boost the pre-service teachers' confidence in their abilities in choosing the right ICT tools to enhance the teaching approaches for a lesson and students' learning.. The post-course survey saw increases in prospective teachers' self-rated abilities of teaching lessons that appropriately combine ICT tools and teaching approaches in Mathematics, Literacy, Science and Social Science. More pre-service teachers believed that they think critically about how to use ICT tools in their classrooms, and that they can adapt the use of their target software application to different teaching activities.

It seems fair to say that that the design principles applied to the design of the new curriculum are viable and have potential to help the development of pre-service teachers' TPACK. However, the improved TPACK at the end of the course could have been attributed by many other factors, such as prospective teachers' exposures to ICT integrations in their curriculum subject areas and knowledge gained in their specific teaching subject areas. Further, prospective teachers' increased TPACK were based purely on course participants' self accounts. It is unclear whether they are transferrable in the classroom contexts. Our design approach may have equipped pre-service teachers with some skills that they can apply to classroom situations. However, as acknowledged by Mishra and Koehler (2006), some simple learning-technology-by-design experiences would not fully prepare teachers. It is perhaps more appropriate to regard the pre-service teachers' experiences with the course as building a foundation of "a beginning

repertoire" (Feiman-Nemser, 2001 cited in Mishra & Koehler, 2006, p. 1039) that prepares pre-service teachers for later experiences of a deeper and more expansive quality (Dewey, 1938). Continuous development of TPACK goes beyond teacher training programs and relies on constant professional development in which awareness created during pre-service education would serve as a foundation.

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