Facilitating Development of Design Efficacy among Singaporean In-Service Teachers through TPACK

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Abstract: Singapore Ministry of Education implemented the ICT Mentor Programme in 2010. This is a professional development programme for a selected group of in-service teachers tasked to develop and cascade effective ICT practices in schools. A TPACK survey was employed in this study to assess the effectiveness of the programme. The results obtained through study of participants from an earlier phase point to possible need for enhancement of the programme. The programme was redesigned. Participants who attended the redesigned programme perceived to have experienced substantial growth in Technological Pedagogical Content Knowledge (TPACK). This is an indication that the redesigning of the programme has yielded its intended results.

Keywords: Design efficacy, in-service teachers, technological pedagogical content knowledge

1. Introduction

The Ministry of Education (MOE), Singapore, implemented three Information and Communications Technology (ICT) masterplans since 1997. The aim of the masterplans is to provide students with skills and learning attitudes to boost their employability in the new knowledge-based economy. Each masterplan built on the success and learnings of the preceding one, taking into cognizance the contexts of technology advancement, changing culture of the use of technology by students, new insights into ICT-enriched pedagogy, budget provisions as well as readiness and competencies of school leaders and teachers to integrate ICT into education. Noting that teachers are one of the key levers, the emphasis on professional development (PD) of teachers is consistently placed throughout the masterplans [11]. To better understand the effectiveness of its PD programmes on ICT-integration for in-service teachers, MOE uses the TPACK framework to review and improve the programmes.

2. Background of Study

The TPACK framework is developed by Mishra & Koehler [7] to profile teachers' competencies in terms of their technology, pedagogy and content knowledge. The framework is built on Shulman's pedagogy and content knowledge (PCK) framework formulated in 1986 [9]. In the TPACK framework, the domain of technological knowledge (TK) is introduced to the PCK domain suggested by Shulman to illustrate and explain how it interplays with the other two domains of pedagogy and content to derive the essential qualities of teacher knowledge for technology integration. These three knowledge components also interact to form overlapping domains, namely technological content knowledge (TCK), technological pedagogical knowledge (TPK), and pedagogical content knowledge and technological pedagogical content knowledge (TPACK), which teachers can tap to shape their practices.

Many studies have employed the TPACK framework to design and evaluate teachers' growth in the knowledge for ICT integration (for example [3,8,10]). With increased emphasis on the use of ICT to transform learning, PD for teachers is seen as key to bringing about effective pedagogical use of ICT in schools. The MOE Singapore, designed an in-service PD programme known as the ICT Mentor Programme to train teachers as ICT Mentors to improve their TPACK. The programme was implemented over five phases from 2010 for about 1,400 ICT Mentors. Such large scale PD is necessary for the implementation of a national initiative. Aware that a one-off after school workshop is ineffective in equipping teachers with the necessary skills, knowledge and disposition needed for reform oriented practices [2], follow-up support was provided by the MOE over the period of one year.

In 2011, a research study was conducted using the TPACK framework to evaluate the effectiveness of the 3-day face-to-face workshop component of the ICT Mentor Programme. Results from the study of Phase 3 ICT Mentors provided positive indications that the approach adopted for the PD is in the right direction. The increase is significant given the short intervention period of three days. However, the effect size analysis obtained through Cohen's d shows the possibility of greater gain if appropriate refinements were done to the PD activities [1]. The results of the study together with feedback gathered from the Phase 3 ICT Mentors were used to inform the re-designing of the 3-day PD activity components of the programme for Phase 5 ICT Mentors. This paper presents the findings of a further study of the impact of the redesigned programme on Phase 5 ICT Mentors.

3. The Revised ICT Mentor Programme

MOE Singapore implemented the ICT Mentor Programme, during the third ICT masterplan, to build a critical mass of ICT teacher advocates or champions to develop and cascade effective ICT practices in schools.

An experiential learning approach was adopted for the PD programme. The ICT Mentors experienced the use of a range of ICT tools in the learning of different subject content and were involved in designing lessons for their own classroom use. They also experienced being coached, so that they could put to practice the coaching skills acquired for mentoring their peers. Professional development in the form of face-to-face subject-based meetings and webinars continued to take place after the initial training to build the competencies of the ICT Mentors. At the face-to-face subject-based meetings, ICT Mentors shared their experiences and challenges faced in lesson design and delivery, and explored ways to further improve and refine the lesson ideas and facilitate students' learning. To help create the necessary conditions to support the ICT Mentors in carrying out their roles, continued support was provided in the form of communication with school leaders and in-schools consultation provided by educational technology officers from the MOE. This overall concept of the programme remains unchanged.

Nominated ICT Mentors started the programme by undergoing the 3-day PD activities delivered in an immersive ICT-enriched learning environment with many hands-on activities and role-modelling by trainers on how technology can be effectively integrated into the subject disciplines. This approach allows ICT Mentors to experience firsthand a learner-centered ICT-enriched learning environment.

In previous phases, the first half of the training programme focused on generic affordances of ICT in learning across different subject-content areas. ICT Mentors experienced ICT-enriched lessons in different subjects followed by lesson deconstruction, discussion and reflection of their experiences. In the second half of the programme, participants worked in specialised subject groups to explore and leverage ICT for learning in their specific subject areas.

The redesigned ICT Mentor Programme for participants in Phase 5 focused on improving the ability of teachers to relate to learning activities in their subject specialization area. Changes were made to the training to focus on subject-specific ICT-enriched learning experiences rather than the generic understanding of ICT affordances and integration. This enabled ICT Mentors to explore and learn about the use of appropriate technology to enhance subject-specific pedagogies to support students' understanding of the content, and how the use of specific technology can change pedagogies as well as the learning content. (See Annex A for summary table)

4. Methodology

Sample

165 teachers were nominated by the schools to participate in the redesigned programme. The participants went through the 3-day PD activity components of the ICT Mentor Programme. A total of 102 teachers participated in the pre- and post-course survey on a voluntary basis.

Procedure

An online pre-course survey was administered prior to the ICT Mentors' participation in the 3-day face-to-face PD activities while a post-course survey was administered online before the 2-day face-to-face PD activities on coaching, which took place about four months later.

Survey Instrument and Data Analysis

The survey instrument used for pre- and post-course survey was adapted from a study of pre-service teachers' TPACK (see [4]). A 31-item questionnaire was formulated to allow the teachers to rate their self-efficacy about their knowledge associated with the seven TPACK factors. The items require the teachers to rate their knowledge level on a 7-point Likert scale.

Exploratory Factor Analysis (EFA) was conducted using principal axis factoring with Direct Oblimin rotation, following the procedure recommended by Costello & Osborne [6]. The data used for the factor analysis was the pretest data before the ICT Mentor Programme was conducted (N=168). The EFA yielded seven factors as shown in Table 1. The total variance explained was 80.5%. In other words, the construct validity of the instrument was established. Item TPCK 1 was dropped as the factor loading was lower than 0.5.

After the training session, 102 participants filled up the post-course survey. The data was matched through the participants' identification number and analyzed using paired sample t-test. This provides the assessment of the teachers' design efficacy for all the

TPACK factors. Cohen's d was then computed to assess the practical effect size of the training. Cohen [5] defined effect sizes as d values of about 0.2 as small effect, 0.5 as medium effect, and 0.8 or above as large effect. ", stating that "there is a certain risk in inherent in offering conventional operational definitions for those terms for use in power analysis in as diverse a field of inquiry as behavioral science".

Findings

Table 1 shows the items and outcome of EFA with principal axis factoring.

Table 1: Results of Exploratory Factor Analysis

		Factor						
		1	**2**	**3**	**4**	**5**	**6**	**7**
TPK3.	I am able to facilitate my students to use technology to plan and monitor their own learning.	.817						
TPK2.	I am able to facilitate my students to use technology to find more information on their own.	.790						
TPK4.	I am able to facilitate my students to use technology to construct different forms of knowledge representation.	.739						
TPK1.	I am able to use technology to introduce my students to real world scenarios.	.595						
TPK5.	I am able to facilitate my students to collaborate with one another using technology.	.540						
CK4.	I am confident to teach the content knowledge for my teaching subject.		.925					
CK1.	I have sufficient knowledge about my teaching subject.		.826					
CK2.	I can think about the content of my teaching subject like a subject matter expert.		.755					
CK3.	I am able to develop deeper understanding about the content of my first teaching subject.		.654					
PCK3.	Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.			.911				
PCK2.	Without using technology, I can address the common learning difficulties my students have for my teaching subject.			.909				
PCK1.	Without using technology, I can address the common misconceptions my students have for my teaching subject.			.791				
TCK1.	I can use the software that are created specifically for my teaching subject. (E.g. e-dictionary/corpus for language; Geometric sketchpad for Maths; Data loggers for Science)				.803			
TCK2.	I know about the technologies that I have to use for the research of content of my teaching subject.				.717			
TCK3.	I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.				.716			
TPCK5.	I can create self-directed learning activities of the content knowledge with appropriate ICT tools. (e.g. Blog, Webquest)					.896		
TPCK2.	I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools. (e.g. Google Sites, CoveritLive)					.808		
TPCK6.	I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools. (e.g. simulations, web-based materials)					.734		

TPCK3.	I can design authentic problems about the content knowledge and represent them through computers to engage my students.	.681		
TPCK4.	I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools. (e.g. Webspiration, Mindmeister, Wordle)	.679		
PK4.	I am able to help my students to reflect on their learning strategies.		.820	
PK3.	I am able to help my students to monitor their own learning.		.791	
PK2.	I am able to guide my students to adopt appropriate learning strategies.		.742	
PK6.	I am able to guide my students to discuss effectively during group work.		.710	
PK1.	I am able to stretch my students' thinking by creating challenging tasks for them.		.674	
PK5.	I am able to plan group activities for my students.		.647	
TK3.	I know how to solve my own technical problems when using technology.			.818
TK2.	I can learn technology easily.			.763
TK1.	I have the technical skills to use computers effectively.			.704
TK4.	I keep up with important new technologies.			.633

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 11 iterations.

Table 2 below shows that there is significant increase in the ICT Mentors' mean ratings for all technology related factors. Their TPACK has increased the most (mean difference = 1.32, Cohen's d = 1.18) followed by TPK (mean difference = 0.62, Cohen's d = 0.67) and TCK (mean difference = 0.68, Cohen's d = 0.65). The impact of the revised programme appears to have high practical significance on the ICT Mentors' in TPACK, TPK and TCK related to leveraging technologies for learning.

Table 2 Pre- Post-tests of Phase 5 ICT Mentors

Components	Pretest (Mean, SD)	Posttest (Mean, SD)	Paired-sample t-test	Effect size (Cohen's *d*)
CK	5.90 (0.68)	5.93 (0.71)	0.37	0.04
PK	5.71 (0.59)	5.84 (0.68)	1.79	0.20
TK	5.22 (1.07)	5.42 (1.01)	2.10*	0.19
PCK	5.25 (1.02)	5.33 (0.91)	0.73	0.08
TCK	4.89 (1.20)	5.57 (0.87)	6.00***	0.65
TPK	5.03 (1.03)	5.65 (0.82)	5.85***	0.67
TPACK	4.28 (1.30)	5.60 (0.90)	9.97***	1.18

* $p<.05$, ***$p<0.001$

Discussion

The study at the present stage yields data to examine the effectiveness of the revised 3-day face-to-face PD activities through an experiential approach in an immersive environment in developing in-service teachers' knowledge of ICT integration. In particular, we investigated teachers' self-rated competencies in their TPACK related knowledge, before and after the course. Using a validated survey instrument, the in-service teachers evaluated how much their knowledge had developed based on the seven factors classified under the TPACK framework. Analysis of the in-service teachers' self-ratings showed significant improvements in TPACK, TPK and TCK as perceived by the teachers. The effect size was high for TPACK and medium for TPK and TCK. The study provided positive indication that the redesigned intervention is effective in producing large gains in the teacher design efficacy. The increase is significant given that TPACK, TCK and TPK are areas directly relating to the teachers' thoughtful pedagogical integration of technology to enable acquisition of content knowledge. Further studies can possibly be done to triangulate the teachers' perceived improvement in TPACK to actual lessons plans designed and conducted by them through using rubrics designed based on the TPACK framework. In addition, research also suggests that further theorizing of the PD employing the TPACK framework in the aspect of design thinking can yield further insights [4,7].

5. Conclusion

The study provided indication that the redesigning of the 3-day PD activities has possibly resulted in the PD activities having a greater impact on the TPACK of the participants in Phase 5 of the ICT Mentor Programme. Thus, the rationale for customisation of the PD activities to the curriculum specialisation and experiences of the participants has yielded the intended results.

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Annex A: Revisions to the ICT Mentor Programme

Area of Change	Revision	Rationale
Training Content	From emphasis on technology for learning to the use of technology in subject-specific pedagogical framework.	To enable ICT Mentors to relate technology integration to subject-specific pedagogy for ICT-enriched lesson experiences that brings about self-directed learning and collaborative learning.
	From coaching that focuses on communication skills to coaching that is within school context.	To provide ICT Mentors with practical tips that can be applied when coaching their mentees.
Approach	Involvement of school leader and middle manager through a pre-training briefing session.	To enable school personnel to understand the rationale of the programme and put in place support structures for ICT Mentors.
	From zonal-based training to cluster-based training.	To enable ICT Mentors to network and provide support for one another.