Examining Technology Integration Decision-making Processes and Identifying Professional Development Needs of International Teachers

Medha Dalal
Arizona State University

Leanna Archambault
Arizona State University

Catharyn Shelton
Arizona State University

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Abstract

This mixed-methods study examines the impacts of a semester-long technology professional development for international teachers from developing nations and is a follow up to our previous work in this area. Using the TPACK framework and a survey approach, first we investigated the international teachers' perceptions regarding their technology integration abilities. Then, a lesson planning design task was used to qualitatively analyze their rationale behind the technology integration decisions and to triangulate. Overall, the results confirmed our earlier findings that despite reporting highest growth in the technological content knowledge on the post-survey, participants intended to use technology with general pedagogical strategies rather than content specific ones. However, the technology access issues were less evident compared to our earlier study, possibly suggesting that availability of technology and its adoption in education may be improving in the developing nations.

Introduction

Globalization trends, first visible in commerce and industry, have also impacted the field of education. As a result, teacher education has begun to embrace more international collaborations and exchange programs in recent years (Charney, 2009; Townsend, 2011). One such exchange effort is the International Leaders in Education Program (ILEP), conducted by the International Research & Exchanges Board, a non-profit organization established with the help of U.S. Department of State's Bureau of Educational and Cultural Affairs (U.S. Department of State, 2017). Since 2007, the ILEP initiative has brought exemplary secondary school teachers from developing nations to the United States for a semester long program at four host universities. The program encompasses: a) coursework on teaching methodologies, curriculum development, and educational technologies, b) field experiences in local high schools, c) exposure to civic and cultural activities, and d) participants designing a professional development module to enhance teaching and learning in their home-schools.

A key component of ILEP is the technology professional development course, which aims to develop teachers' ability to integrate technology meaningfully in their teaching. The course is designed to equip the international teacher participants with education technology resources, skills, and experiences that they can adapt for use in their home classrooms. While there is a plethora of research on technology-related professional development of in-service teachers in developed countries such as Australia, United States, Singapore, and Taiwan (Harris & Hofer, 2011; Koh & Chai, 2014; Liu, Tsai, & Huang, 2015), limited research has examined technology integration expertise of teachers from developing nations (Kozma, McGhee, Quellmalz, & Zalles, 2004; Voogt & Plomp, 2010). This research points to two primary barriers that hinder use of technology in education in developing nations. The first barrier is the poor technology infrastructure and access issues, and the second barrier is the shortage of skilled teachers and trainers who can integrate technology meaningfully in education (Kozma et al., 2004; Makgato, 2012; Olakulehin, 2007). Our earlier study (Dalal, Archambault & Shelton, 2017) conducted with the 2016 ILEP cohort suggested that though the international teachers learned to consider the affordances of technology in their instructional planning after the coursework, technology access issues were pivotal in their choice and use of technology. The current study is a direct follow-up and extension of our previous work to see if we find similar results.

Thus, using a mixed-methods approach, we address the following research questions:

1. What is the perceived ability of integrating technology in instruction for the international teachers before and after a semester long technology professional development course?
2. How do international teachers approach technology integration in their instruction planning following the technology professional development?

Theoretical Framework

Lee Shulman (1986) introduced the concept of pedagogical content knowledge (PCK), recognizing the need for a more coherent theoretical framework with regard to what teachers should know and be able to do. Within PCK, he included "the most powerful analogies, illustrations, examples, explanations, and demonstrations" in a way that facilitate powerful teaching and student learning of complex subject matter (p. 9). Koehler and Mishra (2005) extended PCK, developing a framework combining the relationships between content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) calling it technological pedagogical content knowledge (TPACK). TPACK represents the intersection of all three knowledge domains (content, pedagogy, and technology) and involves an understanding of the complexity of relationships among students, teachers, content, technologies, and practices. As Niess (2005) wrote, "TPCK, however, is the integration of the development of knowledge of integration of the different domains that supports teachers in teaching their subject matter with technology" (p. 510).

Since its formal inception and establishment as a theoretical concept, TPACK has been used by researchers to assess technology-related professional development efforts of teachers (Graham, Borup, & Smith, 2012; Altun & Akyildiz, 2017; Liu et al., 2015). In examining the effective outcome of a technology-related teacher professional development program, TPACK addresses each of the three major components (CK, PK, and TK) and their combinations (PCK, TCK, TPK, and TPACK) needed to ensure high quality instruction. Using this framework, the current study looks for the evidence of TPACK growth among international teachers following the ILEP technology course and also examines the instructional planning approaches of international teachers in relation to TPACK constructs.

Methodology

Context

The study took place over a semester long, technology course at a large university in the United States, one of the designated host centers of the ILEP program since 2013. The course was divided into 10 sessions consisting of three hours each, held from mid-January to April, 2017. The technology professional development was designed based on the International Society for Technology in Education (ISTE) Standards for Teachers (ISTE, 2014) and focused on methods of effectively integrating computer-based technology in teaching and learning. As part of the program, all participants were provided with laptops. The classroom was equipped with access to the internet and one projector.

The technology course was divided into two phases: a) a learning phase with formative assessments and b) a transfer phase with a culminating design task. At the start of the course, all participants were given a brief overview of the TPACK framework emphasizing that knowing how to use technology hardware and software alone does not guarantee effective integration of technology in classroom teaching. Meaningful technology integration requires systematic understanding of technology, subject matter or content, pedagogy, and how these domains work together (Koehler & Mishra, 2005).

The learning phase involved face to face class instruction with hands-on tutorials on topics such as learning theory and technology, digital citizenship, internet safety, web-based communication tools, student and teacher productivity tools, video recording and editing, screencasting, web-based assessment applications, and mobile/online learning. The hands-on tasks varied in complexity from simple synthesis of information such as understanding online safety issues to complex implementation of ideas like creating digital stories or Google forms. At the end of each session, participants were asked to create an artifact either individually or in a small group to demonstrate their understanding and comfort level with the technology (e.g., create a slideshow, participate in online discussion group, or produce a digital story). These artifacts and their presentations served as formative performance assessments for the course.

The transfer phase involved a culminating design task. In the last two weeks of the course, all participants were asked to develop one lesson that integrated at least one educational technology tool they had learned. The design task not only demonstrated the ability of the teacher participants to conceptualize, design, and deliver a unit plan infused with technology, but it also provided an opportunity for the teachers to engage in decision making, while practicing technology integration in their own curricula.

Participants

The study involved 16 international, secondary school teachers, divided equally between males and females, who participated in the Spring, 2017 ILEP cohort. Their countries of origin were Bangladesh, Brazil, Ghana, India, Indonesia, Malaysia, Morocco, and Tanzania. The average age of participants was 38 years, ranging from 24 to 49 years. Their teaching experience ranged from six to 21 years, with an average of 12 years. Participants reported a wide range (four to 23 years) of exposure and experience with computer technology (Table 1).

Table 1. Profile of Participants

Professional and technology experience	Response count	Response %
Content area		
Language Arts	10	62
Science	3	19
Social Studies	3	19
Started using technology		
Prior to Age 10	0	0.0
Age 10 to 15	2	12
Age 16 to 20	4	25
Age after 20	10	63
Exposure to computers		
1 to 5 years	3	19
6 to 10 years	5	31
11 to 15 years	4	25
16 to 20 years	3	19
21 to 25 years	1	6
Time spent on computer in a typical work-day		
No time	0	0
Less than one hour	5	31
About 1 - 2 hours	4	25
About 3 - 4 hours	5	31
5 or more hours	2	13
Comfort level using computer		
Not at all comfortable	0	0
Somewhat comfortable	5	31
Comfortable	7	44
Very comfortable	4	25

Data Sources

Survey. To answer the first research question regarding the perceived ability of international teachers to integrate technology in instruction, we used a survey instrument created previously (Dalal et al., 2017). The instrument was based on the validated TPACK measure (Archambault & Crippen, 2009), but modified for an international teacher population. The goal was to measure teachers' confidence related to all TPACK constructs using closed items on Likert scale. The online survey was administered both before and after the course.

Design task. Over a two-week period at the culmination of the course, all participants were asked to design one lesson plan using at least one educational technology tool in the instruction. The participants were able to choose the technology based on its affordance and the subject matter they wanted to address. Along with the lesson plan, participants submitted a written rationale for their design decisions. This rationale described why they chose a particular technology as well as how the technology would be used by the teacher and/or students. All participants submitted lesson plans and rationale statements online using the course management system.

Limitations

It is important to acknowledge the limitations of this study. A survey instrument is inherently limited by its items and scales (Fowler, 2002), and self-report measures are susceptible to bias (Spector, 1994). Additionally, the study's sample size was small and represents a limited population of international teachers, thus restricting the generalizability of the findings. Moreover, a different design task could yield different results for understanding the technology integration approaches of international teachers.

Analysis and Results

Survey: Perceived Ability of Technology Integration

The Likert-scale TPACK items were assigned values as follows: not at all able (1), rarely able (2), sometimes able (3), often able (4), and most of the time able (5). For each individual item, we calculated descriptive statistics both pre and post coursework (Table 2). Then, descriptive statistics were calculated for the seven TPACK constructs and internal reliability was established by verifying Cronbach's alpha (Table 3).

Table 2. Descriptive statistics for all individual items

		Pre		Post	
Construct	Individual items	*M*	*SD*	*M*	*SD*
TK	I can solve technical problems associated with my computer or network connection.	2.94	0.93	3.69	0.95
	I can address various computer issues related to software (e.g., downloading appropriate plug-ins, installing programs).	2.62	0.81	4.00	0.97
	I can assist students with solving technical problems with their personal computers.	2.25	0.86	3.56	0.89
PK	I can use a variety of teaching strategies to share different concepts with students.	3.25	0.86	4.75	0.58
	I can modify instruction based on my assessment of students' knowledge and skills.	3.69	1.19	4.56	0.73
	I can determine a particular teaching or learning strategy best suited for a particular concept.	3.37	1.15	4.60	0.63
	I can adjust my teaching methodology based on student performance or feedback.	3.19	1.33	4.56	0.73
CK	I can create materials that align with the concepts students need to learn in a course.	3.62	0.96	4.44	0.73
	I can decide on the concepts in my content area that should be taught in a class.	3.62	1.15	4.56	0.73
	I can plan the sequence of concepts taught within my class.	3.5	1.04	4.53	0.64
	I can produce written lesson plans for the classes I teach.	4.19	0.91	4.60	0.63
TPK	I can create a technology-rich learning environment where students can build new knowledge and skills.	2.56	1.15	4.38	0.88

	I can implement different methods of teaching with technology.	2.56	0.89	4.33	0.72
	I can use technology to facilitate communication and interactions among students.	3.00	1.32	4.63	0.50
	I can motivate students to want to use technology for communication and interactions with each other.	3.56	1.09	4.80	0.41
PCK	I can distinguish between correct and incorrect problem solving attempts by students.	3.50	1.09	4.47	0.74
	I can anticipate likely student misconceptions regarding a particular concept.	3.31	1.14	4.31	0.79
	I can assist students in noticing connections between various concepts in a curriculum.	2.56	1.26	4.38	0.72
TCK	I can use technological representations (like an online video, an interactive map, or an online science experiment simulation) to demonstrate particular concepts in my content area.	3.06	1.06	4.47	0.74
	I can implement curriculum using technology.	2.00	1.15	4.47	0.64
	I can use various online courseware programs to deliver instruction (e.g., Edmodo).	2.50	1.17	4.31	0.79
TPACK	I can use technology to predict students' skill/understanding of a concept.	2.19	1.11	4.19	0.83
	I can use technology to create effective representations of content that expand on the content presented in my textbook.	2.94	1.00	4.50	0.73
	I am able to meet the overall demands of teaching a class, using technology.	2.81	1.17	4.40	0.83

Table 3. Descriptive Statistics for TPACK Constructs and Reliability Scores

	Pre-survey Results		Post-survey Results		Post-Pre	Cronbach's Alpha
Construct	*M*	*SD*	*M*	*SD*	*M*	
TK	2.60	0.87	3.75	0.94	1.15	.691
PK	3.37	1.13	4.62	0.67	1.25	.751
CK	3.73	1.01	4.53	0.68	0.80	.627
TPK	2.92	1.11	4.53	0.63	1.61	.788
PCK	3.12	1.16	4.39	0.75	1.27	.763
TCK	2.52	1.13	4.42	0.72	1.90	.817
TPACK	2.65	1.09	4.36	0.80	1.71	.821

Note. Means and standard deviations computed from responses ($N = 16$) on the following scale: not at all able (1), rarely able (2), sometimes able (3), often able (4), and most of the time able (5).

Design Task: Technology Integration in Instructional Planning

To address the second research question regarding international teachers' approach to technology integration in their instructional planning, the lesson plans (N=16) and accompanied rationale statements were analyzed qualitatively. We used a-priori TPACK codes in combination with open coding to understand the technology-related decision making of the international teachers (Corbin & Strauss, 2015; Tracy, 2013). We decided to use both inductive and deductive coding due to limitations of TPACK framework. While the framework is theoretically robust and helpful for organization, the fuzziness of the domains make it difficult to separate out each of the domains, limiting its practical use (Archambault & Barnett, 2010; Kimmons, 2015). In addition, given the new themes beyond the TPACK codes identified in our previous work, including affordance of technology, student-centered learning, discovering new technology, access issues, and teacher-centered learning (Dalal et al., 2017), we wanted to look for similar evidence, if present.

From the submitted design task materials, we identified 94 statements as data or meaning units for further content analysis (Merriam, 1998). Statements were identified as meaning units for analysis if they pertained to either a specific educational technology, a justification for choosing that technology, or its intended use. These statements were extracted and saved in a spreadsheet for further analysis. Together, two members of the research team read and re-read the data units, first coding for one of the presence of the four technology-related TPACK domains (i.e., TK, TPK, TCK, or TPACK). In a second round, open coding (Corbin & Strauss, 2015) was used on the same meaning unit to identify potential additional themes. The data units were repeatedly read and codes were consolidated or expanded as necessary, until coding saturation was reached. Table 4 outlines the 11 codes thus identified with their description and a sample example. Then one researcher coded the remaining data units (78%) which were reviewed by the other members of the team. Any discrepancy was resolved by discussion to reach 100% agreement.

Table 4. Codebook with examples

Code	Description	% Evidence	Example
TK.af (affordance)	Teacher describing what the technology adds to their lesson plan considering the benefits or advantages of technology in education.	11	"Google Forms allows you to ask both open-ended and closed-ended questions."
TK.rc (resource constraints)	Teacher thinking about available technology resources and school policy constraints.	5	"I chose Powerpoint and Youtube because these are the only resources that can be used in my school."
TPK.is (instructional strategy)	Use of technology for a specific instructional strategy or a particular pedagogical goal such as assessment.	21	"After viewing a YouTube video, encourage online discussion by asking learners to add their personal insights: What did they like about the video? Was there anything they didn't understand? How did the video relate to their personal experiences/feelings?"
TPK.af (affordance)	An instructional strategy that involves use of technology specifically considering the affordance of the particular technology tool.	7.5	"Using YouTube videos in lesson encourages your audience to develop their note-taking skills by viewing, rewinding, and replaying the video until they have fully grasped its essence and key points."
TPK.lu (learner understanding)	An instructional strategy that involves use of technology but keeping in mind the background, abilities and motivations of the learner.	7.5	"As a teacher of classes with inclusion students and at risk students, I have found that measurable differences occur in learning and retention …Algebra tiles website can assist their learning process from concrete to symbolic." (learner background) "Skills such as taking notes, writing summary, or reading comprehension are being taught through interesting approaches such as taking note from videos and online articles instead of reading textbook and listening to the teacher." (engagement and motivation) "Students with hearing loss learn by watching and observing, so with technology, they will see the presentation, my delivery using signing language, and observe the graphic organizer

			representing the processes of debate." (learner ability)
TCK.af (affordance)	Teacher talking about a particular technology tool considering its affordance and relevance for specific content.	3	"Chemistry experiments are hazardous, one cannot see what's happening at molecular level. PhET allows to see and conduct experiments again and again if something goes wrong."
TCK.rc (resource constraints)	Considering a technology tool for its relevance to specific content while weighing the technology access issues and resource constraints.	2.5	"Show google earth as it is useful for geography lesson. No internet in school but has personal connection through mobile. The plan to show google earth may fail."
TCK.tp (teacher planning)	Teacher planning the lesson thinking about content and technology.	2.5	"Power point will be used in early stage, (New knowledge presentation) to explain the content of the lesson."
TPACK.is (instructional strategy)	Teacher combining pedagogy, content and technology in instructional strategy however, one domain may be prevalent.	9	"The teacher introduces VoiceThread, an online platform where students can leave their comments on a question/subject given by the teacher. This kind of activity can help students improve their listening and speaking skills." (Pedagogy) "Students will watch the video about exploring the coral reef. Students will discuss and pose questions about the video they have watched." (Content) "They will learn how to produce their learning products by making Prezi presentation, power point show, movie maker and PhotoPeach." (Technology)
TPACK.af (affordance)	An instructional strategy for a particular content that involves meaningful use of technology considering the affordance of the particular technology."	2	"Stop the video at 4:59 minutes and solve the following sums from your textbook based on arithmetic mean. You may watch the video again for clarity and understanding."
TPACK.lu (learner understanding)	Teacher talking about an instructional strategy for a particular content that involves use of technology but keeping in mind the background and abilities of the learner.	2	"Students often have difficulty learning Mathematics especially algebra. It is deemed too abstract and students cannot represent the numbers and variables physically. But students can understand algebraic thinking and its concepts with Algebra tiles website that takes geometric approach to algebraic concepts."

Note. Percentages calculated based on $N = 94$ rationale statements.

Overall, the largest portion (40%) of the data units were related to TPK followed by TK (18%), TPACK (15%), and TCK (8%). Of the statements, 4% could not be coded using a second level as they did not reflect a particular or consistent theme. Thus, total 81% of the data units were coded for one of the technology related TPACK constructs (TK, TPK, TCK or TPACK). The remaining 19% data units simply mentioned specific technologies that international teachers were planning to use in instruction upon return.

These included statements such as, "Students will need mobile phones with internet connection and preinstalled PhEt lab application." or "This Khan Academy video is perfect to teach basic statistics." Specific technologies mentioned by teachers included Kahoot, Voice Thread, YouTube, Prezi, PowerPoint, Moviemaker, PhotoPeach, Screencast-O-Matic, Google Forms, Audiobook, Poll Everywhere, and the Illuminations website from National Council of Teachers of Mathematics.

Examining the secondary level codes, 30% of the statements were related to instructional strategy, 27% suggested thinking related to various affordances of technology, 10% reflected teachers' understanding of their students' backgrounds and abilities, 8% conveyed technology access and resource issues, and 2% of the statements indicated teacher planning. Remaining statements were related to either specific technology names, websites or the 4% of statements that could not be coded for a secondary level.

Discussion and Implications

ILEP participants form a highly heterogeneous group coming from a variety of nations, teaching different subjects and grade levels, and possessing varying levels of technological experience. As was the case with our earlier study (Dalal et al., 2017), the participants began the ILEP professional development program with greater levels of confidence in their CK (3.73), PK (3.37), and PCK (3.12) but lower knowledge levels in all technology-related constructs. This was expected with the average teaching experience of 12 years among the participants, resulting in higher confidence for content knowledge and teaching strategies. However, after completing the ILEP program, participant confidence levels for technology-related constructs advanced significantly to match with other non-technology related construct values; and the biggest gains were reported in technology-related constructs of TCK (1.90), TPK (1.61) and TPACK (1.71). This evidence suggests that the ILEP program's emphasis on educational technology was an effective way to empower the international teachers as confident, more assured integrators of technology.

The qualitative analysis of the lesson plans and rationale statements, however, suggests greater development of TPK compared to TK, TCK, or TPACK. The international teachers included in the study were highly experienced. In addition, the presence of categories of learner understanding such as TPK.lu and TPACK.lu suggest that these teachers were confident that they knew their students well, which again speaks to their experience. Our approach, which leveraged teachers' existing pedagogical skills to impart new technological knowledge may not be as effective for international teachers with less teaching experience. This is consistent with Graham et al. (2012) assertion that building a strong foundation of PCK is key for developing TPACK.

While participants reported the highest confidence gain in TCK (1.90), the design task analysis showed very little evidence (8%) of TCK. It seems that while teachers felt confident in integrating technology across their content areas, their ability to do so in the lesson planning process was still limited. This finding matches the results of our earlier study (Dalal et al., 2017). One consideration is that technology access issues in the developing nations (Buabeng-Andoh, 2012; Voogt & Plomp, 2010) could impact how these teachers designed their lessons. Six out of 16 teachers clearly indicated lack of internet or computers in their school. They were also aware that not all students have access to computers and internet at home. These technology resource constraints would act as gatekeepers, preventing them from designing lessons suggestive of TPACK where technology is used constructively with full involvement of students (Koehler & Mishra, 2005). However, the technology access issues and resource constraints were less noticeable in only 8% of the meaning units as compared to the previous ILEP study (Dalal et al., 2017) where we reported 14% meaning units reflecting technology resource issues with the same number of participants (n=16). This could be an indication of increasingly improving technology infrastructure and penetration of mobile technology in the education scene of many developing nations (Chaudhuri, 2012; UNESCO, 2015).

Other considerations for lower evidence of TCK in lesson plans could be that while there is an explosion of educational technologies for assessments and content-sharing, the technologies themselves are rarely designed with teaching and learning specific content in mind (Laurillard, 2009; Forssell, 2016). Acknowledging this limitation. Forssell (2016) implored designers to leverage teacher knowledge and create digital tools guided by the TPACK framework. Moreover, researchers (Graham et al., 2009; McCrory, 2008) have indicated that during technology professional development it is easier to integrate technologies for general teaching strategies than the technologies intended for specific content. This was a particular challenge in the ILEP technology course because the teacher participants had varied backgrounds in terms of content area, grades, and also curriculum owing to different nationalities. The higher concentration of data units coded for instructional strategy (30%) suggest that while designing lessons teachers were thinking about pedagogy – how were they going to teach a particular topic, what difficulties their students might face, and how were they going to assess the learning. As Archambault and Barnett (2010) specify, the teachers are inherently not thinking about technology skills alone or separating out domains of content, pedagogy, and technology when planning. They are likely considering these elements together, all at once.

An indication of the success of the ILEP technology course was evident when the theme of affordance was noticed in the second level coding of all technology-related constructs including TK.af, TPK.af, TCK.af, and TPACK.af. The knowledge of affordance is suggestive of advanced thinking about how technology can enhance content and pedagogy (Koehler, Mishra, Kereluik, Shin, & Graham, 2014; McCrory, 2008). The teachers learned to consider the benefits and advantages of technology at every stage of instruction planning to see if the teaching-learning process could be enhanced by the use of specific technology tools, rather than simply using the technology for the sake of doing so.

In summary, the international teachers entered the ILEP program with limited confidence in their ability to integrate technology in the classroom. During the semester-long technology course, they explored new educational technologies, built upon their integration skills, and learned to think about the affordances of these technologies in connection with their instructional strategies. Through other activities in the ILEP program, such as observing in local high schools and taking other university level courses, they also had varied experiences with educational technology in action. As was the case with our earlier study (Dalal et al., 2017), the results suggest that while teachers learned to consider the affordances of technology in instruction planning, there remains a distinct need to impart general technology skills and awareness of content specific educational technology tools.

Future work along this line would benefit from similar studies with higher number of participants or with a different design task to explore the decision-making approaches of international teachers. A longitudinal study examining the actual classroom practices would illuminate not only the ability of international teachers to integrate technology in the natural settings of their home countries, but would also shed light on the new approaches needed in the design of technology-related professional development programs for international teachers.

The findings have implications for the future design and motivation of international teacher education programs. International collaborations and teacher exchange programs such as ILEP are the vehicles to provide space and opportunity for teachers to make connections between and among diverse educational issues and engage in meaningful learning that enables them to use technology constructively. Lawless and Pellegrino (2007) have emphasized that the digital divide between urban and rural schools in the United States is not because of a lack of access to technology, but due to the lack of access to teachers who are able to integrate classroom technology effectively. This discovery has even larger implications in the context of developing nations where there is a critical and continuing shortage of teachers and trainers equipped to integrate technology in education (Kozma et al., 2004; Makgato, 2012; Olakulehin, 2007). We anticipate that the current study will provide added focus on the technology-related professional development needs of developing nations and contribute toward longitudinal research in understanding the sustainability of technology professional development efforts in the international context.

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