Towards successful TPACK professional arrangement for in-service teachers

Abstract

Professional development programmes for technology are essential for teacher capacity to improve students' achievement. Technological Pedagogical Content Knowledge (TPACK) framework which represents teachers' knowledge domains, consisting of content, pedagogy, and technology, is used in a number of professional development programmes. This review is aimed at investigating the implementation of in-service teachers' TPACK professional development arrangements for technology integration using technological pedagogical content knowledge (TPACK) framework. In doing so,this review usedfivemajor online databases: ERIC, Web of Science, Scopus, Informaworld, and SpringerLink, with the criteria of studies addressing in-service teachers' TPACK professional development arrangements for technology integration, except for first aim since it addresses the concept of TPACK; deal with teachers teaching students without disabilities; and must be conducted between 2006 and 2012.In general, the results of this review show three different conceptualisations of TPACK model: initial model of TPACK, ICT-TPACK model, and elaborated TPACK model. Moreover, inquiry learning approach, peer-coaching, authentic learning, problem-based learning, project-based learning, and learning activity typeswere employed in successful TPACK professional development programmes for in-service teachers. In addition, several factors contributing to such successful programmes include engagement, authentic learning experiences, collaboration, supports, curriculum coherency, reflection, feedback, intensive training, and longer time. Finally, teachers

were reported having positive experiences with such programmes.

Key words: Professional development; Technological Pedagogical Content Knowledge (TPACK)

1. Introduction

Technological advancehas greatly influenced education, and consequently, educational designers and teachers have benefitted the potential values of technology as a tool for teaching and learning. In this regard, Pineida(2011) maintained that the educational uses of technology seemingly appear to be one of the teacher competencies for educational reform efforts in the 21st century. This is because if technology is appropriately and effectively integrated, it can improve student achievement (Bos, 2007) and brings about innovations that make learning both more authentic and meaningful for students (Warschauer & Kern, 2000; Warschauer & Meskill, 2000; Young, 2003).

Recently, Technological Pedagogical Content Knowledge (TPACK) has been acknowledged in instructional technology literature as an effective framework for technology integration. This framework is based on the work of Mishra and Koehler (2006) as a further development of Pedagogical Content Knowledge from Shulman (1986; 1987). In this framework, Mishra and Koehler (2008; 2006) added a third knowledge domain which represents the need to determine what technology to use, when and in what manner to achieve intended learning outcomes. In sum, this framework forms an intersection of the three knowledge domains, consisting of technological knowledge, pedagogical knowledge, and content knowledge as the core components of teacher knowledge.

This literature review discusses 1) the conceptualisation of TPACK, as identified in different studies, with the objective to understand its nature and its formation, 2) the different instructional methods employed in TPACK professional development arrangements, 3) the factors characterising successful TPACK professional development programmes, and 4) in-service teachers' experiences with such programmes. Studies cited in this paperfor the second, third, and fourth aims were conducted in the context of in-service teacher TPACK professional development arrangements.

2. Aim and research question

This review is aimed at exploring the implementation of in-service teachers' TPACK professional development arrangements for technology integration using technological pedagogical content knowledge (TPACK) framework. The primary question of this review is "*How are successful TPACK professional development programmes organised?* " This main question is divided into the following sub-questions:

1. What are the different conceptualisations of TPACK?
2. What are the instructional approaches used in successful TPACK professional development programmes?
3. What are the contributing factors to successful TPACK professional development programmes?
4. What are teachers' experiences with such successful TPACK professional development programmes?

3. Method

This literature review used several online databases to find relevant scientific studies or articles. In this review, five major online databases were used in searching for relevant studies: ERIC, Web of Science, Scopus,Informaworld, and

SpringerLink.The criteria for the articles or studies to be selected were that 1) they must be empirical studies thataddressedin-service teachers'TPACK professional development arrangements for technology integration, except for first aim since it addresses the concept of TPACK;2) deal with teachers teaching students without disabilities; and3) must be conducted between 2006and 2012.

In order to answer the questions of this review, studies investigating teacher TPACK professional development programmes for technology integration were then explored to investigate the concept, the approaches to instructional methods, the factors featuring successful professional development programmes, and teachers' experience with such programmes. To easily search for relevant studies, general search terms were used, such as *professional development (programme/arrangement)*, *teacher learning*, *teacher training*, or *teacher education* combined with *TPCK, TPACK, and Technological Pedagogical Content Knowledge*. As a result, based on the abstract screening 91articles were retrieved.6 articles for question 1, 13 articles for question 2, 14 articles for question 3, and 5 articles for question 4 were selected and reviewed. Finally, in the results, discussions, conclusions, and limitation parts of the studies weremainly searched and reviewed for the purposes of this review.

4. Results

4.1. The conceptualisation of TPACK framework

The complexity of TPCK or TPACK as a conceptual framework is that it does not have a universally accepted conceptualisation yet. Voogt, Fisser, Roblin, Tondeur, and van Braak(2012), on their review on technological pedagogical content knowledge, identified three views on TPCK. These views are T(PCK) as an extension of PCK, TPCK as a unique and distinct body of

knowledge, and TPACK as the interplay among technology, pedagogy, and content knowledge and their intersection in a specific context.

4.1.1. The initial conceptualisation of TPCK/TPACK

The framework of Technological Pedagogical Content Knowledge (TPCK) as a framework for teacher knowledge is primarily based on the work of Mishra and Koehler (2006) as a further development of Pedagogical Content Knowledge by Shulman (1986; 1987).In this TPCK framework, Koehler and Mishra (2005; 2006), based on the understanding of teaching as a highly complex activity represented from many kinds of knowledge, formed a interplay of three knowledge domains, consisting of technological knowledge, pedagogical knowledge, and content knowledge as the core components of teacher knowledge which they consider fundamental for effective instructional practices. The initial conception of TPCK is illustrated in figure 1 below.

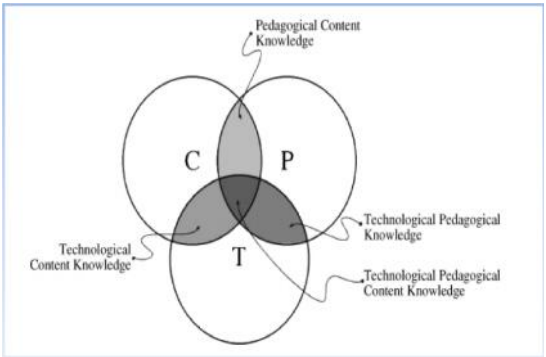

Figure 1: The initial model of TPCK (Mishra & Koehler, 2006)

1. The first domain is *content knowledge*. It is teachers' knowledge and understanding of the subject matter or course being taught

to students, e.g., English, Math, Natural Science, etc. Without this, teachers probably would have difficulties in teaching.

2. The second domain is *pedagogical knowledge*. Having a great deal of content knowledge is not enough for effective instruction. If content knowledge answers the question of *what* teachers teach, then pedagogical knowledge answers the question of *how* teachers teach the content. This knowledge is teachers' understanding of instructional approaches, methods, and classroom techniques with which teachers would be able to provide powerful learning environment.
3. The last domain is *technological knowledge*. Technology here means standard technologies, such as books, chalk and blackboard, and more advanced technologies, such as the Internet and digital video (Mishra & Koehler, 2006, p. 1027). Therefore, technological knowledge refers to teachers' capacity to appropriately select and use technology that best support and promote effective instruction. This capacity allows teachers to integrate technology into their classrooms in which teachers can benefit technology for their own classroom practices. This knowledge also requires teachers' skills to operate technology they use. For example, teachers may have to be able to operate a computer and other technology devices.

These bodies of teachers' knowledge can be connected in pairs as Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK). *Pedagogical Content Knowledge* refers to how teachers teach particular content-based material to students. *Technological Content Knowledge* is how teachers select and then use technologies to communicate particular content knowledge, while *Technological Pedagogical Knowledge* mainly addresses how teachers use particular technologies when they are teaching. Finally, the intersection of the three circles forms a combination of three knowledge domains, the so-called Technological Pedagogical Content

Knowledge (TPCK)(Koehler & Mishra, 2005; Mishra & Koehler, 2006).

The acronym of TPCK as mentioned above was updated in the winter 2007-2008 on the issue in the *Journal of Computing in Teacher Education*. The updated version of the TPCK acronym becameTPACK (Thompson & Mishra, 2007). For this update, they argued that the addition of letter Ain the updated acronym betterrepresents the interdependence of the three knowledge domains (T, P, C), thus explaining the "Total PACKage" of teacher knowledge. Based on this update, the acronym of TPACK will be used next in this article.

Later in 2008, Koehler and Mishra (2008) added context (e.g., students characteristics, school/institution cultures, facilities, etc) to the seven knowledge domains as an indispensable part of TPACK framework. They argued that context is important to learning and situating teacher knowledge and for better understanding and application of the framework; teachers need flexibility in order to succeed. This updated model is depicted in the figure 2.

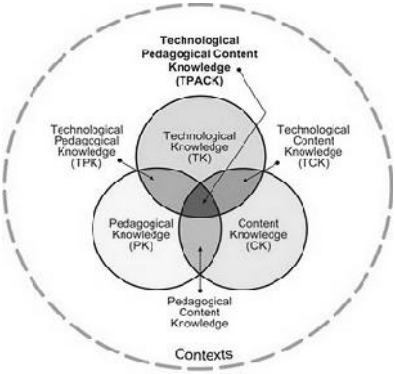

Figure 2 TPCK framework and its knowledge components (Koehler & Mishra, 2008)

4.1.2. The ICT-TPACK

Another conceptualisation of TPACK was developed by Angeli and Valanides(2009), the so-called ICT-TPACK model. They define it as:

> the ways knowledge about tools and their pedagogical affordances, pedagogy, content, learners, and context are synthesized into an understanding of how particular topics that are difficult to be understood by learners, or difficult to be represented by teachers, can be transformed and taught more effectively with ICT, in ways that signify the added value of technology (p, 158-159)

This conceptualisationhas the three main domains of TPCK (subject matter knowledge, pedagogical knowledge, and technology (ICT), and two additional components, namely, knowledge of students and knowledge of the context within which learning takes place. However, the knowledge domain of learners mentioned here is similar to the conceptualisation in Shulman' PCK (1986). These main components are briefly described as follows:

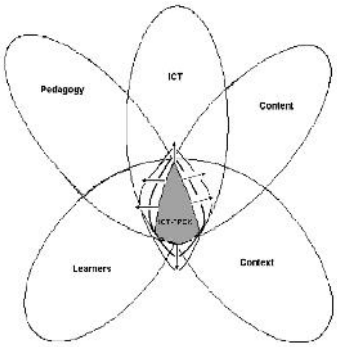

Figure 3: ICT-TPACK (Angeli&Valanides, 2009)

1. Subject matter knowledge refers to an understanding of the facts and structures of a content domain.
2. Pedagogical knowledge refers to broad principles and strategies of teaching, classroom management, and organization that are generic across different subject matter domains.
3. Knowledge of learners refers to their characteristics and preconceptions that they bring to a learning situation.
4. Knowledge of context ranges from the workings of the classroom, to the educational values and goals, as well as their philosophical underpinnings in conjunction with teachers' epistemic beliefs about teaching and learning.
5. ICT knowledge is defined as knowing how to operate a computer and knowing how to use a multitude of tools/software as well as troubleshoot in problematic situations (p, 158).

This conceptualisation regardsthe knowledge domains in TPCK as a separate component of teacher knowledge that can be developed and assessed independently from one another. This feature is contrary to the concept from Mishra and Koehler (2008)who claimed that the development of one's knowledge in TPCK represents the development in all three knowledge domains (technology, pedagogy, and content).

4.1.3. The elaborated TPACK framework

The elaborated TPACK framework presented here was proposed by Cox and Graham (2009).In this model, the framework also has the three main components of knowledge, but has different conceptualisations of TPACK and its components.

Pedagogical Knowledge (PK) is simplified to focus on the teacher knowledge of the general pedagogical activities that teachers may use. General activities in this pedagogical domain are independent

of a specific content or topic. It means that they can be used with any content and may include strategies for motivating students, communicating with students and parents, presenting information to students, and classroom management among many other things. Additionally, this category includes general activities that could be applied across all content domains such as discovery learning, cooperative learning, problem-based learning, etc. Then, Content Knowledge (CK) simplyrefers tothe knowledge of the possible topic-specific representations in a given subject area. This knowledge domain is independent from pedagogical activities or how teachers might use the representations to teach.Pedagogical ContentKnowledge (PCK) thus refers to how to utilize topic specific representations in conjunction with subject or topic-specific activities to help students learn(Cox & Graham, 2009, pp. 62-63).

Moreover, Cox and Graham (2009, p. 64)define Technological Knowledge (TK) as the knowledge of how to use emerging technologies, and Technological Content Knowledge (TCK) refers to knowledge of the topic-specific representations in a given content domain that utilize emerging technologies. The paired combination of TK and PK (TPK) is the knowledge of the general pedagogical activities that teachers can engage in using emerging technologies. Thus, TPK might include knowledge of how to motivate students using technology or how to engage students in cooperative learning using technology. These are independent from a specific content or topic. This is not because they do not involve content, but because they can be used in any content domain.

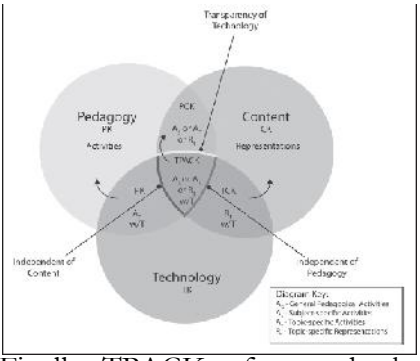

Figure 4: An elaborated TPACK from Cox and Graham, 2009

Finally, TPACK refers to the knowledge of how to coordinate the use of subject-specific activities or topic-specific activities with topic-specific representations using emerging technologies to facilitate student learning(Cox & Graham, 2009, p. 64). This elaborated model can be seen in the figure 4above.

In summary, three conceptualisations of TPACK were introduced. First, the conceptualisation from Mishra and Koehler (2008; 2007;2006) sees TPACK as teachers' understanding of the integrated knowledge domains in specific contexts. Second, the ICT-TPACK developed by Angeli and Valanides(2009)views TPACK as consisting of separate knowledge domains that can be developed and measured in isolation from one another. Third, an elaborated TPACK as conceptualised by Cox and Graham (2009) has simply expanded each definition of TPACK components. All these three conceptualisations of TPACK employed in studies addressing TPACK professional development arrangements were considered for identifying the approaches, factors, and experiences of teachers as discussed in the following sections.

4.2. Approaches to TPACK professional development programmes

For the investigation of the successful approaches to TPACK professional development programmes, only 13 articles met the

criteria for being selected in this review. Next, the results concerning general findings are grouped into two: instructional approaches and delivery format.

With regard to instructional approaches, the results of the studies in this review addressing the approaches to TPACK professional development arrangements varied. The approaches found in those studies were *inquiry learning approach*(Doering, Veletsianos, Scharber, & Miller, 2009; Guzey & Roehrig, 2009), *peer-coaching*(Jang, 2010), *authentic learning approach*(Jimoyiannis, 2010; Jimoyiannis, Tsiotakis, & Roussinos, 2011; Nicholas & Ng, 2012), *project-based approach*(Allan, Erickson, Brookhouse, & Johnson, 2010; Blocher, Armfield, Sujo–Montes, Tucker, & Willis, 2011; Polly, 2011; Trautmann & MaKinster, 2010), *problem-based learning approach (PBL)*(Tee & Lee, 2011), and *learning activity types*(Harris & Hofer, 2011).All of these studies (e.g., employing evaluation study, design-based research, etc), confirmed that theabove-mentioned approaches they usedenhanced teachers' TPACK development.

Concerning*inquiry learning approach*, two studies were retrieved using such approach to in-service teachers' TPACK professional development programmes (Doering et al., 2009; Guzey & Roehrig, 2009). In the study by Doering, et al. (2009), the meta-cognitive awareness of social studies teachers in technological, pedagogical, and content knowledge (TPACK) improved after their participation. This programme consisted of professional development for the use of an online learning environment and using an online learning environment in their classrooms. The teachers were reported to experience considerable movement within the TPACK diagrammatic knowledge domains and expressed positive and encouraging comments regarding their knowledge domains portrayed within the TPACK framework.Furthermore, the study of Guzey and Roehrig(2009)also employed the same learning approach. They

argued that this approach enhances teacher learning. With this approach, Guzey and Roehrig(2009) in their study required four in-service secondary science teachers to write a technology integration plan and afterwards implemented it in the classrooms. Each teacher was also asked to design and conduct action research. This study reported that providing those teachers with the opportunities to build and sustain learning communities appeared to have positive impacts on teachers' development of TPACK.

The *peer-coaching approach* was also employed in the study of Jang (2010) in Taiwan. He executed a programme in one semester in which he implemented the IWB-based TPACK–COIR model. This model included 1) TPACK comprehension in which they discussed the main activity for understanding the content of TPACK and teachers were allowed to study the content of TPACK in teams, 2) observation of peer instruction was that one teacher demonstrated his teaching of integrating IWB technology with respect to the unit assigned. Afterwards, the teachers and the researcher had chances to give their comments and suggestions, 3) instruction and video recording in that each teacher selected an appropriate teaching strategy or representation to integrate the IWB technology design according to the knowledge acquired from the study of relative references or books, and then the teachers executed theirdesigned lessons in their own classes, and 4) TPACK reflection, consisting of reflection and modification, the science and the researcher teachers sit together to analyse the videotapes of their teaching. The science teachers shared their teaching experiences with each other, and wrote down their reflections in their journals.

Studies also showed that *authentic learning approach* has a positive effect on TPACK development (Jimoyiannis, 2010; Jimoyiannis et al., 2011;Nicholas & Ng, 2012). Jimoyiannis(2010, p. 1265) argued that teachers want to learn and develop new skills related

to their instruction in meaningful and realistic learning settings. The activities with this approach engaged teachers in planning, developing, evaluating and revising ICT-based learning activities.In a study where its professional development programmeorganised in a 4- intensive day over 7 weeks (Nicholas & Ng, 2012), it started with workshops comprised of the first two days of an expert in Picaxe-based electronics workshop to understand the electronics associated with the UniBoard using the Picaxe microcontroller and the second 2 day workshop led by education academics from the university. These two workshops were followed by experts and teacher associates visits on the schools regularly to assist the teachers implement the programme in their classes. With this approach, it reveals that teachers increased confidence and willingness to grow professionally (Nicholas & Ng, 2012). This study, however, did not assess teachers' knowledge or skills gained after participating in the programme.

The use of *collaborative project-based approach* also helped teachers develop technology skills (Allan et al., 2010; Blocher et al., 2011; Polly, 2011;Trautmann & MaKinster, 2010). The collaborative project-based approach to technology focusingon curriculum development as reported by Allan, et al. (2010), 20 ecology teachers were assigned to develop EcoScienceWork curriculum as guidance to the use of computer simulations and to include related field experiencesfor students'hands-on activities in ecology. They claimed that it demonstrated significant teacher gains in technology skills, new knowledge in the use of simulations in teaching, positive changes in pedagogy, and increased content knowledge.Then, in another study, teachers involved in activities to learn technology skills embeddedand contextualized within the learning activity that they could then later take into their classroom. In doing so, they were grouped by grade level and given the opportunity to practice technology integration by designing lessons for their classes. Through this

collaborative nature, teachers planned, taught, evaluated, and finally reported their experiences to the Community of Leaders. After having such experiences within two years, the teachers were reported to significantly increase their technology skills (Blocher et al., 2011).Furthermore, Polly's study(2011) involving 54 teachers,the literacy facilitator, and the technology facilitator used Google Documents to collaboratively create a curriculum map for the school year. Wiki was used for a place for teachers to share effective instructional resources and questions. Through a case study, it is reported that the teachers' knowledge of specific components of TPACK was enhanced, especially TK, PCK as well as CK. The last, Trautmann and MaKinster(2010) investigation by introducing use of geospatial technologies through application to specific topics in environmental science after which 11 teachers were provided with time to practice using new tools and data sources while also considering how they could apply these resources within their curriculum and with what pedagogical approaches during one year, showed significant growth in teachers' perceived technological expertise, interest, and ability to integrate geospatial technology into their science teaching.

Another approach, *improvised problem-based learning approach (iPBL)*, was implemented in the study of Tee and Lee (2011). This approach was guided by the SECI framework: socialisation, externalisation, combination, and internalization, consisting of four phases. The first phase was to give students time to provide some context and definition to the problems, directly from what they were facing in their real life teaching context. The second phase was for the teams to consider different solutions, and then to propose and select a solution. The third phase was for each group to implement the selected solution in a pilot or full-blown situation, and subject it to further evaluation. Finally, the fourth phase was for students to present and discuss the process and outcome of the entire learning cycle (p, 92-93). All of these

phases were conducted in a course on technology in teaching and learning.

Finally, *learning activity types* was another approach that Harris and Hofer (Harris & Hofer, 2011) employed in their descriptive study. This begun with creating awareness of the range of possible learning activity types within a particular content area, matching them to multiple ways that both digital and non-digital technologies can be used to support each type of learning activity. Then, teachers selected activity types in that particular content area, combining the types selected in ways that are congruent with students' standards-based, differentiated learning needs and preferences. These activities were reflected in Harris and Hofer's study with seven teachers during five months.With this approach, the teachers could choose and use learning activities and technologies more conscious, strategic, and varied. Their instructional planning also led to be more student-centred instruction, and the quality standards for technology integration were raised, resulting in deliberate decisions for more judicious educational technology use (Harris & Hofer, 2011, p. 211).

Concerning delivery formats, two formats of TPACK professional development programmes were identified in the studies reviewed here. The six programmes were conducted through projects (Allan et al., 2010; Blocher et al., 2011; Doering et al., 2009; Guzey & Roehrig, 2009; Nicholas & Ng, 2012; Polly, 2011), while seven programmes were organised via courses(Jang, 2010; Jimoyiannis, 2010; Jimoyiannis et al., 2011; Niess, Zee, & Gillow-Wiles, 2010; Tee & Lee, 2011; Trautmann & MaKinster, 2010). For an example of professional development through courses, an online course was used to develop teachers' TPACK. Organised for the elementary and middle school levels, Niess, et al. (2011) used four stages consisting of engaging teachers in the exploration of spreadsheet capabilities within specific mathematics and science units and problems, developing themes

and unit for integrating spreadsheets, considering assessment for students' outcomes when solving mathematics and science problems with spreadsheets, and finally planning and scaffolding student learning with spreadsheets. This study claimed that the teachers developed from recognizing to accepting, adapting, and exploring TPACK levels.

In comparison to the above findings, Niess(2011) identifies several strategies for delivering TPACK in guiding teachers toward the development of a robust knowledge for teaching with technology. These approaches include self-assessment, learning-by-design approach, instructional modelling, collaborative lesson studies, meta-cognitive exploration of TPACK, action research, and TPACK-based case development strategy. However, all of these approaches were not found in the studies cited in this review.

To sum up, six instructional approaches to in-service teachers' TPACK professional development were identified: inquiry learning approach, peer-coaching, authentic learning, problem-based learning, project-based learning, and learning activity types. These approaches required the participants of those studies to learn under constructivist approach, and were employed in two modes of programme organisations: projects and courses. All these approaches, those instructional approaches and modes,could help in-service teachers cultivate TPACK and its knowledge domains.

In addition, it seems to indicate that both formats are good for TPACK professional development programmes; and project-based approach and authentic learning approach apparently indicate good approaches as these two were adopted in many studies reporting successful TPACK professional development programmes for in-service teachers in this review.

4.3. Factors characterising successful TPACK professional development programmes

Different factors were identified in the successful implementation of TPACK professional development arrangements for in-service teachers. Those features are *involvement*(Blocher et al., 2011; Jimoyiannis et al., 2011), *authentic learning experiences*(Doering et al., 2009; Jimoyiannis, 2010; Tee & Lee, 2011),*collaboration(Allan et al., 2010; Jimoyiannis et al., 2011)*, *guidance and support* (Blocher et al., 2011; Doering et al., 2009; Guzey & Roehrig, 2009; Oster-Levinz & Klieger, 2010; Trautmann & MaKinster, 2010),*curriculum coherency*(Nicholas & Ng, 2012),*reflection*(Allan et al., 2010; Guzey & Roehrig, 2009; Harris & Hofer, 2011; Jimoyiannis, 2010; Tee & Lee, 2011),*feedback*(Jimoyiannis, 2010; Niess et al., 2010), *intensive training*(Trautmann & MaKinster, 2010), and *time*(Jimoyiannis, 2010; Nicholas & Ng, 2012; Oster-Levinz & Klieger, 2010).

The first characteristic which contributes to successful TPACK professional development programmes is *involvement*. Blocher, et al. (2011) stated that teachers felt comfortable and confident in using technology after they were being engaged in the professional development programme. In an evaluation study, Jimoyiannis, et al. (2011) also claimed that the critical foundation for the instructional design framework should address teachers' engagement because it became one of the parameters to make their programme successful.This feature is important as it could motivateteachers to fully understandthe concept they were learning.

Three studies in this review confirmed that the *authentic learning experience* is also fundamental. Tee and Lee (2011) assigned the participating in service-teachers to design authentic or simulated complex situations and the finding showed that the teachers became better positioned to use TPACK more fruitfully. Moreover, Doering, et al. (2009) provided teachers with authentic

geographic content to developed their content knowledge. This feature is essential because teachers' development on TPASK requires authentic learning experiences with respect to real class situation (Jimoyiannis, 2010).

Related to *collaboration*, two studies (Allan et al., 2010; Jimoyiannis et al., 2011)confirmed the significance of collaborative working experiences. For instance, it is reported that teacher change was occurring serendipitously through the collaborative curriculum development project with the emergence of teacher leaders (Allan et al., 2010). Jimoyiannis, et al. (2011) further contended that collaboration in their study became a critical parameter for a successful program.

Guidance and support also appear to constitute such successful programme(Blocher et al., 2011; Guzey & Roehrig, 2009;Trautmann & MaKinster, 2010). This form of support, for example, could be in terms of peer-support as indicated in the study of Blocher, et al. (2011) in which teachers established a relationship over the extended period and called upon one another for support and outside resources; or expert support as reflected in the study of Doering, et al. (2009). In the same tone,Guzey and Roehrig(2009) asserted that support should be continuous. It is necessary to help teachers overcome the constraints and difficulties they encounter in technology integration. To support those claims, research finding showed that support plays a significant role in the implementation of the integration of technological knowledge with the teachers' pedagogical content knowledge (Oster-Levinz & Klieger, 2010). In this regard, Trautmann and MaKinster(2010)mentioned two types of supports. These include ongoing technological and curricular support to help teachers maintain momentum and overcome inevitable glitches (p, 367).

The importance of the relevancy between the professional development programmes with curriculum was indicated in three studies (Harris & Hofer, 2011; Nicholas & Ng, 2012;Niess et al., 2010). According to Nicholas and Ng (2012), the programmeshould match with the curriculum as it is necessary to link where it sits within the curriculum (Nicholas & Ng, 2012). This is also supported by Niess, et al. (2010), stating thatthe content-specific emphasis ofthe course engaged teachers in activitiesrequiring them to seriously think about curriculum contents withdynamic spreadsheets. In addition, Harris and Hofer (2009) maintained that the curriculum content is important since it is the primary focus of the instruction.

Besides, *being reflected* on what had been done suggested successful implementation of TPACK programme(Allan et al., 2010; Guzey & Roehrig, 2009). In one study, for instance, teachers were required to reflect on their classroom practices in order that they could incorporate technology and inquiry into their teaching more effectively (Guzey & Roehrig, 2009). The opportunities for teachers to discuss and share in sufficient time were needed in order that teachers could have informal conversation and build strong personal and professional relationships (Allan et al., 2010).

Feedback is also essential for teacher learning. Feedback through assessment was implemented in a professional development programme through a course in a 3-year online master degree programme focusing on the integration of technology with science and mathematics teaching and learning (Niess et al., 2010). The assessment was done on the teachers' assignment of the course. And, feedback, particularly continuous feedback to the teachers' works, is critical to support teachers' learning and performance.

Moreover,Trautmann and MaKinster(2010) mentioned that intensive training is important to enhance teachers' understanding

and practices. This can be assumed that intensive training would give teachers opportunities to deeply understand the concept and its application related to specific tasks and contexts.

Finally, time also matters. Time, the duration of the professional development programme, had an effect on the programme (Jimoyiannis, 2010; Nicholas & Ng, 2012; Oster-Levinz & Klieger, 2010;Trautmann & MaKinster, 2010). For instance, the effect of time, which is expressed by the acquisition of experience, contributes to the integration of the technological knowledge with the teachers' pedagogical content knowledge (Oster-Levinz & Klieger, 2010). According to Trautman and MaKinster(2010), substantial time must be invested in mastering use of the technology, creating effective ways of integrating it into science teaching, and remaining sufficiently up to date in a field of rapid change (p, 368).

In summary, successful TPACK professional development programmes consider a number of contributing factors. This review suggests that teachers should be actively engaged, provided with authentic learning experiences, encouraged to work collaboratively, given supports, working based on the curriculum, reflective, given feedback on performance, provided with intensive training, and given sufficient time.

4.4. Teachers' experiences with TPACK professional development programmes

Teachers had positive experience with participating inTPACK professional development programme. These positive experiences had been shown in terms of comfort, confidence, willingness, interest, and satisfaction. Blocher, et al. (2011) claimed that one-half of their participating teachers reported their improvement in their comfortand confidencein using technology by participating in the programme. Another study also showed

that all teachers reported their increased willingness and confidence, particularly in their ability to apply ICT in their own instruction (Jimoyiannis, 2010; Jimoyiannis et al., 2011). Furthermore, Doering, et al. (2009) asserted that in-service teachers who went through the TPACK-based program experienced and expressed positive and encouraging comments regarding their knowledge domains portrayed within the TPACK framework. Teachers were also reported being satisfied with the programme and perceived that the programme had a positive impact on their development(Jimoyiannis et al., 2011). The last, but not the least, a study conducted by Trautmann and MaKinster(2010) found that teachers showed significant growth in interest and high level of satisfaction at the end of each school-year workshop.

These findings advocate several positive experiences of teachers participating in TPACK professional development programmes, as indicated by their comfort, confidence, willingness, interest, and satisfaction.

5. Discussion and Conclusion

As technology develops so rapidly, teacher professional development arrangements on how to integrate technology into instruction or teaching becomes essential nowadays. Lawless and Pellegrino (2007, p. 575)argue that such professional development is critical to ensuring that teachers keep up with changes in student performance standards, become familiar with new methods of teaching in the content areas, learn how to make the most effective instructional use of new technologies for teaching and learning, and adapt their teaching to shifting school environments and an increasingly diverse student population. However, one arising question on technology integration is on the framework for such purpose. Based on the literature, TPACK

(Mishra & Koehler, 2006)appears to a good framework for integrating technology into instruction.

This literature review reveals that the conceptualisation of TPACK framework suggests various models which are respectively based on a variety of perspectives. Voogt, et al. (2012) grouped these various understandings into three main categories: T(PCK) as an extended PCK, TPCK as a unique and distinct body of knowledge, and TPACK as the intersection among the three knowledge domains. Of the three models, one study (Jang, 2010)adopted the ICT-TPACK, one study(Niess et al., 2010)followed the elaborated TPACK, and ten studies incorporated the conceptualisation from Mishra and Koehler (2006). However, one study (Guzey & Roehrig, 2009)followed a conceptualisation from McCory (2008) which is not identified in this review. Therefore, TPACK as the interplay among three knowledge domains is the most often used conceptualisation of TPACK in successful TPACK professional development programmes for in-service teachers (e.g., Allan et al., 2010; Blocher et al., 2011; Doering et al., 2009; Jimoyiannis, 2010). The conceptualisation from Mishra and Koehler (2006) is assumed as a well-known framework for technology integration by the designers, when compared to the ICT-TPACK and the elaborated framework.

The review on the empirical research in TPACK professional development programmes for in-service teachersalso shows consistent findings. In organising teacher professional development arrangements, several approaches were deemed effective. These include *inquiry learning approach*(Doering et al., 2009; Guzey & Roehrig, 2009), *peer-coaching*(Jang, 2010), *authentic learning approach*(Jimoyiannis, 2010; Jimoyiannis et al., 2011; Nicholas & Ng, 2012), *project-based approach*(Allan et al., 2010; Blocher et al., 2011; Polly, 2011; Trautmann & MaKinster, 2010), *problem-based learning approach (PBL)*(Tee & Lee, 2011), and *learning*

activity types(Harris & Hofer, 2011). Most of these approaches could help teachers develop TPACK and its knowledge domains and, in some studies, contribute to teachers' positive experiences. Theseinstructional approaches lay on the theoretical principles of social constructivism, asserting that knowledge is constructed through social interaction and is a shared rather than an individual experience; knowledge acquisition is an adaptive function designed to organize experiences; and knowledge is the result of active mental processing by the individual in a social environment (Prawat, 1996; Prawat & Floden, 1994; Vygotsky, 1978). It is thus argued that this social constructivist theory is deemedan appropriate approach to help teachers learn to integrate technology, and is believed to stimulate deep learning and useful experiences.

With regard to the characteristics or factors contributing to successful implementation of TPACK programmes, as revealed in this review, several critical features are suggested, including active engagement in their professional development, authentic learning experiences as to make learning meaningful for them, collaboration that can help them decrease loads and learn from one another, support, working based on the curriculum,reflection, feedback on performance, intensive training,and longer time. In supports of these findings, Lawless and Pellegrino also supported these consideration by stating that professional development programmes are usually organised in a longer duration, to provide access to new technologies for teaching and learning, to actively engage teachers in meaningful and relevant activities for their individual contexts, to promote peer collaboration and community building, and to possess a clearly articulated and a common vision for student achievement (Lawless & Pellegrino, 2007, p. 579; Todorova & Osburg, 2010).In addition, for English language teaching setting, Richards and Farrell also indicated that teacher development serves a longer-term goal and seeks to facilitate growth of teachers'

understanding of teaching and of themselves as teachers (2005, p. 4). With regard to collaborative learning, Darling-Hammond (2003, p. 278)emphasised that teachers learn best if they study, do, and reflect; if they collaborate with other teachers; if they look closely at students and their work; and if they share what they see. This indicates that teachers should be provided with a collaborative environment for authentic learning that promotes and encourages them to practice it in real classrooms.

Most of the studies adopted some phases for teachers' development of TPACK. Introducing the concept through workshops, for instance, helped teachers develop an understanding of practical skills they need for integrating technology. Following this, teachers were required to apply such concept by which they experienced authentic design tasks in collaboration, for example curriculum materials or contents. In some studies teachers enacted the designed materials with students. To enhance these stages, teachers were given opportunities to reflect on. Also importantly, feedback and support were given to sustain the implication of the programme. As was found, support was given after the programme to ensure that teachers continued the change. In line with Joyce and Showers (1995)who suggested four development stages for professional development programmes that should be taken into account, include the presentation of theory; theory and demonstration; theory, demonstration, and practice; and theory, demonstration, practice, and follow-up. As reported by Bradshaw (2002), positive effects by applying this approach with which teachers involved in professional development activities that include theory, demonstration, practice, and follow-up are more likely to transfer technology skills into teaching than those who participated in professional development activities that did not include all four dimensions. Although not completely followed the stages as mentioned by Joyce and Shower, the studies in this

review at least adopted similar sequencing activities for teachers' TPACK development.

Having the above-mentioned concept, instructional approaches, and features, generally teachers had positive learning outcomes and experiences, ranging from improved confidence, comfort, and willingness to the understanding of TPACK. Therefore, successful TPACK professional development program me can be premised on principles of effective professional development as follows.

1. Technology integration into instruction needs a workable framework, providing teachers with a clear formulation on how to integrate technology; therefore, TPACK framework as suggested by Mishra and Koehler (2006) is deemed appropriate for such purpose.
2. In-service teachers' experiences are highly valued for adult learning theory. Constructivist views learning as starting from such experiences and authentic learning approach can be adopted to provide meaningful learning for teachers.
3. For more effective programmes, teachers' engagement in their professional development, authentic learning experiences, and collaboration should be encouraged during the professional development programmes.
4. While acknowledging those above-stated guidelines, support, and working based on the curriculum, reflection, feedback on performance, intensive training, and longer time for the programme should also be taken into account as to strengthen learning and performance.

6. Limitation of the study

This literature review is written from several research findings on the implementation of TPACK professional development arrangements based on a number of research approaches. This review is an empirical finding derived from a number of selected studies; however, not all studies related to this discussion could be retrieved and analysed due to the author's limited accessibility to the articles.

This review also does not distinguish between different implementations of TPACK programmes for teachers in different context. Most of the studies cited in this review were conducted in Europe and US, only two studies were done in Asian context ((studies by Jang, 2010; Tee & Lee, 2011).In addition, this review also does not focus on the implementation of TPACK programmes for a specific subject matter, such as science or English. Therefore, this review findingis difficult to generalise to certain contexts because different contexts might have different characteristics and values.

This review thus needs further elaboration and studies to better understand the issues of TPACK professional development arrangements, particularly studies focusing in a certain context and in a certain subject. Despite these limitations, this current review at least gives a general overview of in-service teachers' TPACK programmes, but this review should not be considered as more or less scientific but rather as a portfolio that can help create insight into the concept of TPACK and its practical implementation for in-service teachers. Finally, the results of this review could serve as a basis for future studies to enrich our knowledge and understanding about these variables.

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