TOWARDS MEASURING TPACK IN INDONESIAN ELEMENTARY PRE-SERVICE TEACHERS

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Abstract

Technological and Pedagogical Content Knowledge (TPACK) has, in recent years, been the focus of considerable research, particularly in subject specific domains. This paper explores the ideas of TPACK and its relationship to Indonesian elementary pre-service teachers. Links are drawn between Hunt's (2015) use of graphic organisers to explore *teaching practices, curriculum connectedness*, *attributes of the teacher* and *use of ICT artifacts* and a theoretical planning tool, TRIM, the Technological Reflective Integration Matrix (Setiyanti & Hunt, 2016). The outcomes outlined here are preliminary, but encourage the researchers to improve the TRIM model as a way to capture a broader picture of TPACK in a domain not well researched -- elementary pre-service teachers.

Introduction

Considerable attention has been given in recent times to the notion of Technological and Pedagogical Content Knowledge (TPACK). Whilst this lies in the ideas of Mishra and Koehler (2006), its origins are much earlier in the work of Shulman (1986, 1987), Pedagogical Content Knowledge (PCK) and Pedagogical Reasoning and Action (PRA). Recent attention (Koehler, Shin, & Mishra, 2012; Harris, Grandgenett & Hofer, 2010; Abbitt, 2011) has focused on exploring the TPACK capacity of teachers and pre-service teachers, most frequently in subject specific domains. This paper is focused on TPACK and elementary teachers who are required to have a much wider Content Knowledge (CK).

In 2015, Hunt used graphic organisers to determine the ideas and beliefs held by pre-service teachers around perceptions held of ICT teachers. This led to a framework based on: first, *teaching practices*: Pedagogical Knowledge (PK); second, *curriculum connectedness:* (Pedagogical Knowledge (PK) and Content Knowledge (CK)); third, *attributes of the teacher* and *use of ICT artifacts:* Technological Knowledge (TK) and Technological Content Knowledge (TCK). The framework of this earlier work (Hunt, 2015) is combined with Hunt's theoretical planning tool, TRIM, the Technological Reflective Integration Matrix. This is another graphic organiser designed to focus on the integration of technology in learning and reflection on teaching practices. TRIM was developed in October 2010, but has not been published.

It is investigated here with a cohort of 35 Indonesian pre-service elementary teachers in their fourth year to identify its potential to 'measure' TPACK in elementary pre-service teachers. Whilst the outcomes are preliminary, they provide encouragement to the researchers to focus on how to improve the TRIM model as a means to capturing a broader picture of Pedagogical Knowledge (PK), Content Knowledge (CK) and Technological Knowledge (TK). This is important for academic staff that need this information to build and deliver courses based on known needs, in this instance, the development of Content Knowledge, which is problematic for elementary teachers.

Literature

The Technological Pedagogical and Content Knowledge (TPACK) framework derives from Shulman's (1986) idea of pedagogical content knowledge (PCK), the integration of Pedagogical Knowledge (PK) and Content Knowledge (CK). In using TPACK in planning and thinking, teachers bring together knowledge of subject matter, what is good for learning, and technology (ICT). The framework also relies on Shulman's Pedagogical Reasoning and Action (PRA) work (1987*). Content Knowledge (CK)* is the knowledge of subject matter, whilst *Pedagogical Knowledge (PK)* is about knowledge of the processes or methods of teaching. TPACK (Mishra & Koehler, 2006) has added a further dimension to the work of Shulman, resulting in a broader set of knowledges that are integrated. Diagram 1 illustrates this notion.

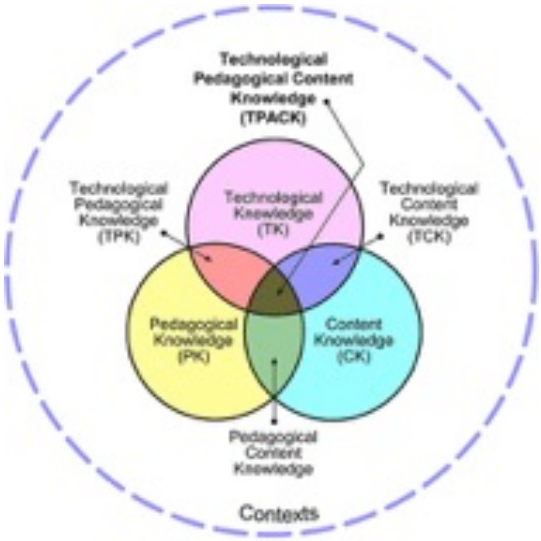


Diagram 1. The TPACK matrix.
(Image source: http://tpack.org)

A wide range of researchers has tried to measure TPACK (Koehler et al., 2012; Harris et al., 2010; Abbitt, 2011). Expert teachers are now considered those who can bring together knowledge of subject matter, what is good for learning, and technology (TTF, n. d.).

Researchers have used a range of strategies to determine TPACK capability, most often with pre-service teachers; the types of approaches used have included:

- Semi-structured interviews (Harris, et al., 2010; Niess, 2006)
- Analysis of teachers' lesson plans using a rubric (Harris, et al., 2010)
- Questionnaires, open-ended responses from open questions (So & Kim, 2009)
- Self-report surveys (Schmidt et al., 2009)
- Observation protocols (Harris, et al.,2010)
- Graphic organisers (Hunt, 2015; Relmasira, Thrupp, & Hunt, 2016)

This research has particular interest in exploring the TPACK of elementary teachers, whereas previous research has tended to focus on subject specific instances with pre-service secondary teachers in mathematics, science, languages and social history. Knowing the TPACK of pre-service teachers enables courses to be developed in areas of need, placing tertiary educators in a better position to respond to areas of perceived weakness. In pondering the use of self-reporting surveys, an example of such a device attempting to 'measure' Content Knowledge is shown (Table 1): the researchers are not confident that these four questions alone can address the domain of CK. This is a reflection of concerns about closed questions.

Table 1

Typical Self-Reporting Survey Questions about Content Knowledge

CK1 I have sufficient knowledge about my teaching subject.
CK2 I can think about the content of my teaching subject like a subject matter expert.
CK3 I am able to gain deeper understanding of the content of my teaching subject on my own.
CK4 I am confident about teaching the subject matter.

Note: Adapted from "Surveying In-service Preschool Teachers' Technological Pedagogical Content Knowledge" by J. C. Liang, C. S. Chai, J. H. L. Koh, C. J. Yang, & C. -C. Tsai, 2013, *Australasian Journal of Educational Technology*, *29*(4), 586.

Elementary teachers require a different set of knowledges, particularly in the domains of CK, PCK and TCK. This requires different strategies to produce a rounded view of TPACK. The researchers have been encouraged by the development of a rubric (Harris et al., 2010) to analyse teacher TPACK, together with the work of Hunt (2015) and Relmasira et al. (2016) in using graphic organisers. This decision is based on belief (that is to be tested) that a single tool cannot identify the breadth of TPACK capability: a solution is thought to lie in combining the rubric (modified and presented as a TRIM (Hunt, 2010, unpublished) and graphic organisers (Draw a teacher/classroom, Hunt, 2015; Relmasira et al., 2016).

Research Questions

RQ 1: Can elementary pre-service teacher TPACK be measured more effectively using a blend of tools as opposed to a singular survey?

RQ 2: How effective are graphic organisers and rubrics in identifying the seven domains of TPACK?

Methodology and Data Collection Instruments

This research uses a mixed methodology and is both qualitative and quantitative. Data were collected during a 90 minute Master Class with pre-service elementary teachers, using pencil and paper activities and an online environment. The instruments are research based and included analysis of teachers' lesson plans (Harris et al., 2010; Niess, 2006), open-ended responses from open questions (So & Kim, 2009) and graphic organisers (Hunt, 2015; Relmasira et al., 2016).

Participants were given four tasks to complete. The first required them to draw a picture of a classroom they would like to have, showing this from a bird's eye view. The second task asked them to use an online tool (TodaysMeet) to describe what a contemporary teacher looks like, sounds like and feels like. Third, they were asked to enter another TodaysMeet Room to identify the tools used by contemporary teachers. Fourth, they were walked through how to use a Technological Reflection Integration Matrix (TRIM) and to design a lesson plan using this model. The TRIM is at the heart of the Master Class and is described here in its original and unpublished form (October, 2010). See Table 2.

Table 2

What is a TRIM?

Setiyanti &Hunt, 2016

A ***TRIM*** …

- is a form of graphic organiser.
- is a visual representation. In this instance, the visual consists of a matrix (the ***trim*** organizer) and words that tell the story.
- helps to organise thinking, in this situation, thinking about ICT Integration.
- has four organisers --
    1. The Task: open-ended questions are best.
    2. The Technologies: what is available?
    3. The Pedagogies: class organization, use of collaborative and cooperative activities, embedded Higher Order Thinking.
    4. The Advantages for Learners: Is it - inclusive, accessible, connected, rich in intellectual quality, and does it recognise difference?

The matrix encourages teachers to *reflect* on the quality of ICT *integration* in a lesson or unit.

An example of a TRIM completed by a participant is shown in Table 3.

Table 3

A Sample of a Completed TRIM From a Participant in the Master Class

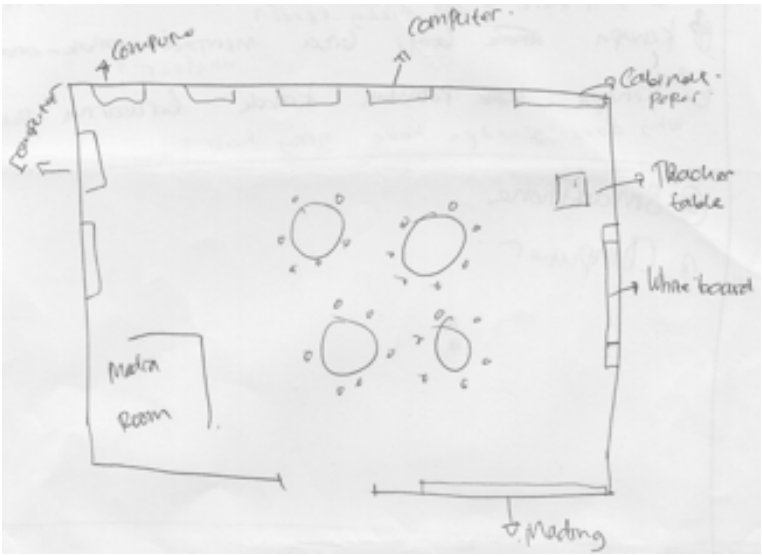
The Task	How can we make crafts using natural materials? (CK, PK)
The Technology proposed	LCD projector (TK, PK) Speakers (TK, PK) computer and Internet (access to information) (TK)
The Pedagogies to be employed	Small group research (collaboration and cooperation) (PK) Groups reporting back to class and sharing (PK) Knowledge construction (PK mediated through PK, PCK, TK and TCK
The Advantages for learners	Shared knowledge (PK) Relevant and connected curriculum (CK) Rich in intellectual quality (PK)

This matrix is not dissimilar in form to the rubric of Harris et al., (2010). It differs in that it seeks to identify the TPACK dimensions in each row of the TRIM Matrix, shown by the annotations attached.

Data Collected and Analysed

Task 1 (n=35): *Draw a picture of a classroom from a bird's eye view*.

In response to this task, 35 students submitted drawings of an ideal classroom layout. Of these, 27 reflected traditional classroom designs that might be termed teacher-centric: the teacher was placed at the centre or front of the class, and desks/seating were arranged in rows or as a half-moon (semi circular). The remaining eight showed a rather contemporary view where desks were arranged in clusters of four to six and randomly placed around the classroom. Some respondents suggested spaces be made for computer use or practicing presentations.



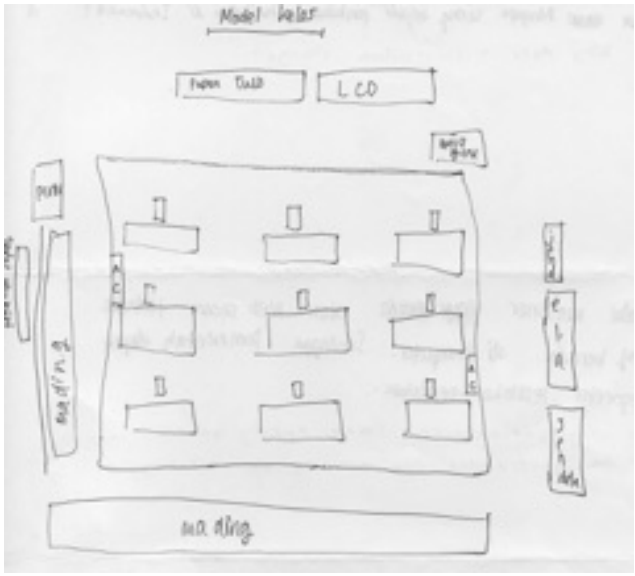


Diagram 2: A contemporary classroom (first) and a traditional classroom (second).

This activity probed PK in particular and could be used by teacher educators to focus on classroom organization and thinking/sitting behind different ways of organizing a classroom to maximize learning. Aspects of TK and TPK were evident in the students' pictures where space was allocated for computer use. In both images, the teacher (guru) is placed at the front of the class; the differences lie in class organization and the tools of teaching. Both have placed an emphasis on the use of LCD (data projector).

Task 2 (n=35): *Using TodaysMeet, describe what a contemporary teacher looks like, sounds like and feels like.*

Common responses to this task included notions such as: friendly, good, fun, open minded, understanding, delivering learning, feelings (empathy) for students, always there and supportive. This activity provided a further insight into PK, particularly ideas such as supportive, friendly, open minded and understanding.

Diagram 3: Word cloud of common responses to Task 2.

Task 3 (n=35): In *TodaysMeet, identify the tools used by contemporary teachers.*

In response to this task respondents offered ideas such as: media (YouTube), creativity, hands on materials, real data, thoroughness, visual materials/aids, books, stories, cooperation, experiments, attractive animations, technologies, the environment, new and modern tools such as computer and the Internet, videos to elicit student thinking, and LCD (data projector). This task and its analysis added to understanding of TK, TCK and PK.

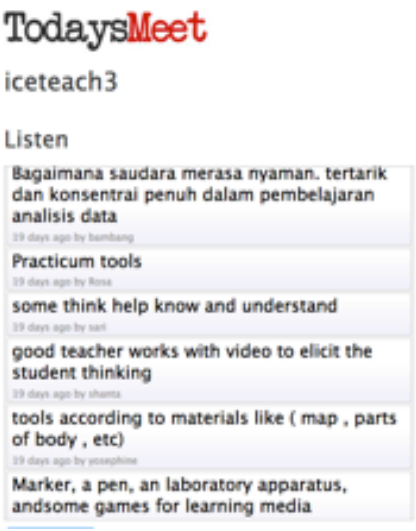


Diagram 4: Screenshot of the conversation thread related to the above task.

Task 4 (n=35): *Develop a Technological Reflection Integration Matrix (TRIM).*

The matrices developed started with a TASK description, a question to ask, a topic to discuss or a research problem to investigate. Some students focused on topics close to their studies, including: Why does the curriculum change so often? What are good strategies to improve your English? Why do we have to shower twice a day? What does nationalism mean to Indonesians? What are your aspirations and Why do we need to go to school? to How can we remove corruption from Indonesia? These ideas are relevant contexts for the students and give an insight into their Content Knowledge (CK), or a desire to enhance their CK. More importantly, they show open-ended questions likely to stimulate Higher Order Thinking (PK). This relevance to the students' lives is also indicative of a curriculum connectedness and context for learning. The open nature of the tasks suggested is also inclusive and encourages all students to participate and have a voice.

The use of technology integration (TK, TCK) was also canvassed in the second row of the matrix and drew such ideas as: use a computer, use the Internet, use video clips for learning (most referenced), make voice recordings, show pictures and lessons using an LCD (data projector), use a national database of teaching plans, and use Hand Phones (HP) to communicate and find information The range of ideas proffered, whilst not as wide as perhaps in a developed nation, shows an understanding of what is available in schools.

The third row of the TRIM sought ideas mainly around Pedagogical Knowledge (PK) and included ideas such as: small group discussion in a practice or quiet space in the classroom (most common idea); develop a group paper/presentation, group analysis and discussion of video clips; working in groups to share ideas, working and thinking together; having group sharing sessions; problem based learning; collaborative and cooperative learning. Working in small groups was most common in the TRIMs analysed, followed by collaboration and problem based learning. The final stage of TRIM asks students to identify Pedagogical Advantages (PK, CK) for learners. When examined as part of the broader TRIM matrix, it is possible to make links to the domains of the TPACK framework (as illustrated in Table 3). Responses included:

- Growing and sharing knowledge about an idea.
- Students work on areas of interest to them.
- Students understand better when working together in groups.
- Teamwork leads to deeper understanding.
- Students improve social skills when working in a group.
- Students construct (facts) though knowledge sharing.
- Students develop deeper thinking.
- In groups, they can share the technology available.

Discussion

The use of these four tasks has provided an insight into the TPACK of the cohort of elementary pre-service teachers who participated. If the teacher educators at the university were to examine artifacts such as these, it would provide direction for the re-development of Pedagogy and Curriculum courses taught. An analysis of these artifacts, a result of a quick 90-minute workshop, shows where minds need to be re-focused. A simple graphic of a classroom provides information about classroom design and layout; questions about the qualities of teachers tells about the self-perceived qualities required of teachers; and the question about the tools teachers use indicate notions of teachers who are seeking to teach as they were taught and those who seek to make a pedagogical difference.

In considering the four tasks given, the matrix in Table 4 shows how each task has contributed to understanding TPACK.

Table 4

Matrix Illustrating the Visible Aspects of TPACK in Each Row of TRIM

The Task	The information in this section provides an insight into participants understanding of content (CK) and context. When examined further, it is possible to identify aspects of higher order thinking (PK and PCK).
The Technology	Whilst this is limited by the context of the classroom (Indonesia), elements of TK and TCK are evidenced.
The Pedagogy	This row provides examples of PK, PCK, and TPK.
The (Pedagogical) Advantage for Learners	These tasks enable learners to: share knowledge, work with a connected and relevant curriculum, and complete tasks that are challenging and rich in intellectual quality
Note: The claims above are dependent on (a) the quality of the task (b) access to a range of technologies and (c) the use of collaborative and cooperative classroom strategies. These are a part of an ongoing learning process for students.	

In the next paragraphs, the research questions are discussed.

RQ 1: *Can elementary teacher and pre-service teacher TPACK be more effectively measured using a blend of tools?* The use of these four tasks has provided a measure of pre-service teacher TPACK. Singularly, they do not provide a rich view. Understanding prior knowledge and beliefs is important, for both pre- and in- service teachers. However, knowing a TPACK profile alone does not change practice but it can inform measures to be taken to move forward from past practices. Knowing what they (students) already know or bring to the party underpins constructivist practice.

RQ 2: *How effective are graphic organisers and rubrics in identifying the seven domains of TPACK?* The domains of TPACK can be seen in most of the samples provided, although the balance is rather erratic. Many students are using traditional classroom organization and do not make explicit the use of collaborative and cooperative strategies. Technology use is limited, and an artifact of the general situation in many Indonesian schools and educational institutions. Having said there, it has been observed in other studies by the researchers that this is an area that is improving rapidly. TRIM is a tool for reflection on practice, and it might be expected that, over time, a better balance will be evident across the four themes of TRIM.

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