Investigating Pre-Service Science Teachers (PSTs)' Technological Pedagogical Content Knowledge Through Extended Content Representation (CoRe)

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Abstract. The purpose of this study was to attain an insight into pre-service science teachers' technological pedagogical content knowledge (TPACK) as an integrative competency that is addressed by 21st century skills. The methods used in the study was descriptive. Nineteen pre-service science teachers (PSTs) of an educational university in Indonesia were involved in a semester long school science course. The course mainly develop students' pedagogical content knowledge (PCK) by utilizing content representation (CoRe) template. Furthermore an infusion of technological knowledge (TK) analysis led to the study of their TPACK by extending the template with a question in line to TK. The extended CoRe and self-reported survey were employed as instruments. The analysis of data used were quantitative and qualitative technique to obtain the insight into PSTs' PCK and TK. The results shows contrary value of PCK and TK identified by CoRe template to those measured by self-reported survey. However, the PSTs perceive their TPACK much higher, that, is 74.74%. Further investigation regarding PSTs ability to compose lesson plan was recommended for further research to capture more comprehensive insight into PSTs' TPACK.

1. Introduction

Technological Pedagogical Content Knowledge (TPACK) has emerged to unpack how teachers integrate technology into their teaching as well as to improve the quality of teaching with ICT. The framework provides a new way of thinking about preparing teachers to teach and learn with technology [1]. Furthermore, TPACK has been widely used as a tool to investigate the effectiveness of technology use in science classrooms because it is considered to help teachers make connections among technology, subject matter of science, and pedagogical knowledge [2] .

TPACK comprises seven constructs which are *technological knowledge (TK)*, *pedagogical knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), pedagogical content knowledge (PCK) and technological pedagogical content knowledge (TPACK)*. TK refers to knowledge about various technology that can be implemented in everyday life as well as in teaching and learning activities. PK is the knowledge about teaching and learning strategies. CK is knowledge about the actual subject matter to be learned. TPK, TCK and PCK refers to knowledge about interplay between the original constructs. Thus, TPK is

knowledge relates to how technology can be use appropriately for particular teaching and learning strategy. TCK relates to how specific technology play importance role in delivering certain content so as to it is being conveyed successfully. Meanwhile, PCK relates to how certain teaching and learning strategy fits subject matter delivery [1]. Constructs of the framework including the intersections is shown in figure 1.

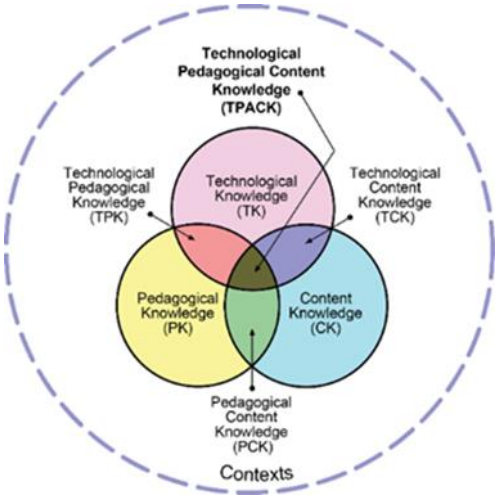

Figure 1. Technological pedagogical content knowledge (Retrieved from www.tpack.org)

Several studies have been conducted to capture insights into pre-service teachers' TPACK. Pre-service science teachers involved in 2-year master of teaching program infused technologies that fit to the content and context that aimed at facilitating non-experimental and experimental inquiry experiences [2]. Another aspect that was found to influence pre-service teacher competence in integrating ICT was ICT course experience [3]. However, pre-service teachers from diverse major found difficulties in understanding pedagogical knowledge when they involved in a technology integration course employing instructional design model [4]. On the other hands, proto-TPK was found as a keystone to set a starting point for interconnected development of TPK with pre-service teachers in their study at university [5].

The studies mentioned above commonly employ TPACK self-reported survey to captures TPACK constructs. However, there has no one that investigate TPACK constructs by involving Content representation (CoRe)- the origin of PCK instrument. Thus, this study aims at investigating Pre-Service Science Teachers (PSTs)' Technological Pedagogical Content Knowledge through Extended Content Representation (CoRe).

2. Research method

Descriptive method was utilized in this research to portray pre-service science teacher TPACK linked to their PCK. This study was the final part of a sixteen meetings 'school science' course aimed at preparing pre-service science teachers' competence in planning to teach science at a schooling year 7 to 9 (12-15 years old). At the beginning of the course, the pre-service science teachers were trained to construct CoRe in peer for several science content area. In this session, students' presentation and discussion were conducted to triangulate their PCK. Constructing CoRe for the topic being investigated was then conducted after they fluently constructing CoRe. The investigation was focused on the content area for 'Human Digestive System'. Meanwhile, investigating TPACK was carried out by employing two extending CoRe questions as well as self-reported survey in order to depict pre-service science teachers' perception on their TPACK.

Nineteen pre-service science teachers (PSTs) at a teacher education university in Indonesia were involved in this study. Moreover, instrument of the study consists of CoRe template [7] and TPACK

self-reported survey that was adopted. In addition, a question linked to pre-service teachers' TPACK were added to the template. Those questions were asking technology preference in teaching certain idea and the way to compensate the absence of preferred technology.

Data were analysed qualitatively and quantitatively. Qualitative analysis was employed to capture pre-service science teachers' PCK on the basis of broadened CoRe template. The answers to CoRe template questions were identified and coding into big ideas emerged and teaching difficulties might pre-service science teachers confront. In addition, technological knowledge was investigated by questions no. 9. Addressed to technology preference in teaching particular idea. In order to grasp participants' TPACK, descriptive statistics was used to recap pre-service science teachers' perception on their TPACK.

3. Results and discussion

1.1. Pre-service science teachers' PCK

By implementing the extended CoRe, this research have indentified PSTs' PCK. Moreover, for 'Human Digestive System' it is captured six big ideas which are: *1) Human needs a food containing enough essential nutrition to be healthy, 2) Food digestion is helped by the digestive organs and accessory digestive glands, 3) Ingestion, digestion, absorption and excretion are the process of food digestion in human body, 4) Digestive deficiency can be caused by internal and external factor, 5)Food processing in digestive system occur in several stages which involves chemical and mechanical digestion, and, 6) Human's digestive system begins from mouth and ends at anus*.

Those big ideas are considered as an important means of depicting pre-service science teachers' PCK. It leads the investigation to the way pre-service science teachers' build the limitation of the topic, and can be viewed as the main ideas that they view as worth way to help students comprehend the whole topic. The big ideas are then explored by the second row of the CoRe asking pre-service science teachers to state the reason behind the importance for students to know these big ideas. The answers to these question delineate their reasons for developing this topic in this way. Regarding big idea 1, one PSTs viewed that it is important to the students to learn big idea 1 because learning this idea is supposed to lead the students to choose better food, so they will stay healthy. By stating the big idea and the reason behind emerging it, pre-service science teachers start to direct the learning into the stuff of content area and deliver it by means that clearly aimed. It is line that as science teachers begin to uncover their content knowledge they then focus on what matters in a content area and teach the matter for particular purpose and focus in developing a conceptualization of the subject area [7].

Pre-service science teachers' difficulties is captured by the fourth row of the CoRe template. For example, a participant views that there are various kind of vitamins, notably vitamin B. Students might confuse about it and thus the teacher should find appropriate technique to teach this content very well. Another difficulty that is confronted is for big idea 6. A participant views that it will be difficult to the students to learn about enzyme since it is a new concept for them. By this case it is found that the deeper content knowledge is needed to identify the depth of certain concept since the concept of enzyme for junior high school should be appropriately convey in accordance to the level. Thus, this questions help the researchers to arrest teacher insight through 'Human Digestive System' content area. Teachers begin to build and respond to insights they obtain about difficulties when teaching certain topic, and, PCK start to appear.

1.2. Pre-service science teachers' TK captured by extended core

Technological knowledge (TK) was captured by an additional question regarding technology pre-service science use to overcome the difficulties of teaching particular idea. The preference of technology for big idea 1 is shown in Table 1.

Table 1. PSTs' preference of technology usage.

Hardware	Frequency	Software	Frequency
Laptop	8	Flash simulation	1
LCD Projector	5	Digital images	1
Audio device	1	Power Point™	3
		Web learning resource	2
		Game software	1
		Video	1
		Audio software	1

Based on Table 1, it is shown that there are three kinds of hardware considered to support the learning of big idea 1, that are laptop, LCD projector and audio device. Meanwhile, seven software types chosen are flash simulation, digital images, power point, web learning resource, game software, video and audio software. This finding can be interpreted as TK posed by PSTs since TK can be represented by typical hardware and software [6]. This finding reveals the importance of preparing teachers educator to more emphasize technology involvement in regard to 21st century skills.

In order to validate PSTs PCK and TK the self-reported survey then being analyzed. PSTs' perception of their seven TPACK constructs is shown in Figure 2.

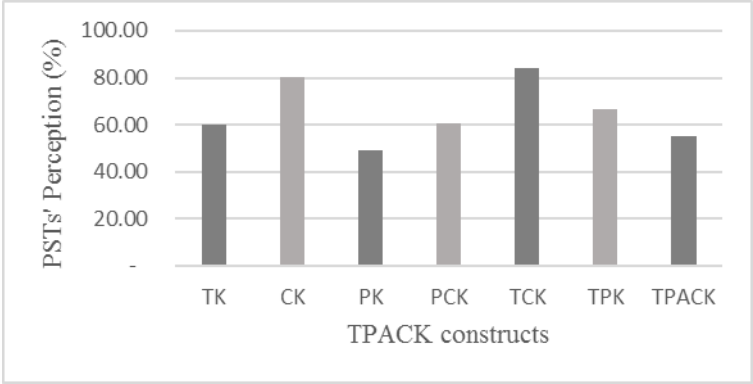

Figure 2. PSTs' perception on TPACK seven constructs.

Based on Figure 2, it is shown that PSTs perceive their TK as many as 60.15%, 80.26% for CK, 48.87 for PK, 60.53% for PCK, 84.21% for TCK, 75.94% for TPK and 74.74% for TPACK. This finding indicates that PSTs' PCK reach low value which is 60.53%. In contrast, in CoRe template PSTs state the importance of teaching particular idea as well as choosing the way appropriate to conceptualize it. Likely, TK reach low value as well which is only 60.15%. This finding is proving that PSTs TK are still low. This is validated by the preference of technology devices and software that is captured in Extended CoRe template. This extended CoRe template can be used to capture PSTs' TK. However, PCK is found to be contrary between that in CoRe template and self-reported survey. With that, it is known that PCK cannot be totally extended into any ways. Rather, it is more complex than merely about knowledge of students' conceptions and knowledge of instructional strategies [7]. Moreover the only extended CoRe template cannot be used to investigate PSTs constructs of TPACK. Comprehensively, another proxy is needed to complete the investigation. This finding is inline with several previous study that imply the need of lesson plan to capture teachers' TPACK in practical context [6]. Thus, further research may implement more various instrument to validate PSTs TPACK, such as, PSTs' lesson plan.

4. Conclusion

Extended CoRe template can be used to capture PSTs PCK and TK. PCK was represented in big ideas arisen and difficulties might confronted by PSTs in teaching the ideas. TK appeared in term of various

kind of typical technology that are chosen to support teaching the ideas. However, the results of extended CoRe is not line with that in self-reported survey. Despite PSTs perform their PCK in extended CoRe, they still perceive it low in self-repoted survey. To better understand seven constructs of TPACK, it is needed another lens which is PSTs' lesson plan.

5. References

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