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ANALYZING TPACK ABILITY OF SCIENCE TEACHER BASED ON EXPERIENCE FOR TEACHING GLOBAL WARMING IN SECONDARY LEVEL

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Abstract

There is a large volume of published studies describing Technological Pedagogical and Content knowledge (TPACK). TPACK has been known as teacher's competency of integrating technology into learning process. This thing also viewed as a modern signature pedagogy within science teachers education integration of technology with science area content and effective pedagogy. In this article the author purposes to describe TPACK of science teachers using a new contextualized TPACK model with global warming. The participants were science teachers from three districts in Indonesia and have different ages from 24 until 34 years old. They were completed questionnaire to measure their ability to sync content, pedagogy, and technology in global warming material. Content Representation was applied to support quantitative data. Our results reveal that the teachers have different knowledge of TPACK. The implications of this study are that experienced teachers perceived higher barriers in integrating technology in classrooms than less experienced teachers.

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INTRODUCTION

One of the most significant current discussions in education research is teacher competency in using technology (Gellerstedt, Babaheidari, & Svensson, 2018). This ability allows the learning process becomes more effective and efficient so as to obtain better results (Ditzler, C., Hong, E., & Strudler, N. 2016). Effective teaching for conceptual change can be facilitated when teachers has a solid TPACK that they have good understanding of the content as well as strategies to present it (Widodo, 2017).

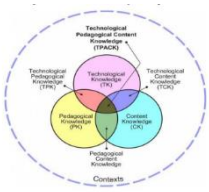

Figure 1. Teacher's TPACK framework

TPACK is the integration of technological, pedagogy and content knowledge (Mishra & Kohler, 2006). A teacher's TPACK profile can also be used for self-reflection on how they can integrate their knowledge (Kuz, 2015; Tanak, 2018). If teachers learn how to make good use of technology (information and communication technology), they are more likely to create better learning environments for students. The use of technology in learning would require expansion in our understanding of the framework of the teacher's knowledge as it has been introduced by Shulman (1986), Pedagogical Content Knowledge (PCK) to the new framework that includes Technological Knowledge (TC), so its called as Technological Pedagogical and Content Knowledge (TPACK) (Mishra & Kohler, 2006). Teachers can self evaluate and improve their learning in different components of TPACK (Al-Harthi, Campbell, & Karimi, 2018). However, TPACK is also a challenge for teachers, so they will take ways to improve it.

Lehiste (2015) shows that the TPACK ability of teachers can be improved through training, workshops, or professional development programs. During the training the teachers are directed to design learning that integrates technology. So that the TPACK ability of teachers is increasing. However, the research of Thomas J.P (2017) shows that over time, the ability of teachers to integrate technology decreases because it is no longer applied. The reason teachers do not use technology as practiced is the limited time and complexity of the technology used. Research berfore do not shows the factor that can influence teacher TPACK. Therefore, the outputs of this research is to provide an overview of how teacher TPACK can influenced by teachers teaching experience.

This study selected global warming content because this material still often creates misconceptions for students (Yanti et al., 2015; Nugraha, 2011; Tjasyono, 2018). An example of a conceptual error that often occurs is related to the greenhouse effect. Students think that the average increase in temperature of the earth is due to the many buildings that use glass on Earth. This assumption is wrong, on this basis, this study wants to re-examine the subject of global warming in order to get a clear picture of the teachers of what concepts are important to be taught in this material.

Given the importance of the TPACK framework, a great number of quantitative studies have been devoted to developing various instruments to measure teachers' TPACK (Brinkley-Etzkorn, 2018). However, much work is still required for enhancing the validity of the TPACK instruments for multiple reasons. Researchers have begun to show the relationship between teacher gender and teacher's TPACK or its relationship with teacher's personal characteristics (Cheng & Xie, 2018; Irmak & Tüzün, 2018). But few studies have been carried out to measure secondary teachers knowledge. Therefore, the primary purpose of the study was to use a TPACK questionnaire developed by Schmidt (2009) for secondary school science teachers to describe teachers TPACK based on their learning experience.

METHODS

Descriptive method was utilized in this research (Creswell, 2012). It used to portray science Teacher's TPACK based on their learning experience. The selection of participants used the convenience sampling method. Convenience sampling method was carried out because the study used one school and only three teachers were willing to be studied. Participants in this study were science teachers at junior high school level in Sidrap district, South Sulawesi. They were completed questionnaire to measure their ability to sync content, pedagogy, and technology in global warming material. The instrumentation of this study was TPACK Questionare developed by Schimdt (2009) to measure the three types of teacher knowledge. The instrument contains seven knowledge domains with 30 surveys item in total. Table below shows representative item in each domain of TPACK.

Table 1. TPACK domain and representative item (Schmidt, 2009)

Domain	Representative item
TK	I know how to solve my own technical problems
	I can learn technology easily
CK	I have sufficient knowledge about global warming
	I have various ways and strategies of developing my understanding of global warming
PK	I know how to assess student performance in a classroom
	I can adapt my teaching style to different learners.
PCK	I can select effective teaching approaches to guide student thinking and learning in global warming
TCK	I know about technologies that I can use for understanding and doing social studies
TPK	I can choose technologies that enhance students' learning for a lesson
TPACK	I can teach lessons that appropriately combine literacy, technologies, and teaching approaches.

The instrument quantitative data gained by TPACK questionnare and to support that data, we applied Content Representation (CoRe) developed by John Loughran (2013). There are eight questions in the CoRe instrument, namely:

1. What will you teach students about this concept?
2. Why are these concepts important for students to learn?
3. Ideas/concepts related to what you think is not the time to be known by students?
4. What difficulties/limitations might you experience to teach the concept?
5. What are the conditions of students (initial knowledge/ways of thinking/interests)/ what are the considerations in teaching this concept?
6. What factors are your considerations in teaching the concept?
7. What sequence/path do you choose to teach the concept
8. How do you know that students understand or not?

Constructing CoRe for the topic being investigated was then conducted after they fluently constructing CoRe. The investigation was focused on the content area for 'Global warming. Meanwhile, investigating TPACK was carried out by self-report measures using the questionnaire and from their CoRe.

RESULTS AND DISCUSSION

The teacher's educational background and teaching experience can be sccccceen in the table below.

Table 2. Teacher information background

Teacher Code	Gender	Age	Teaching experience
G1	Female	37 yr	> 10 yr
G2	Female	28 yr	> 5 yr
G3	Female	24 yr	< 5 yr

The TPACK instrument used in this study is comprised of seven knowledge domains. Teacher have to show an intuitive understanding of the complex connectivity between the three basic components of knowledge (CK, PK, TK) (Hidayat, A 2019). Figure 2 shows each teacher competencies in every domain.

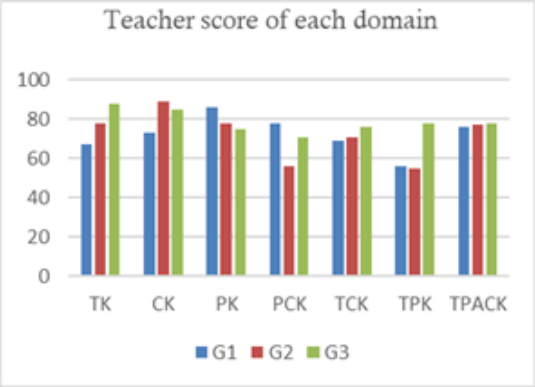

Figure 2. Teacher score of each domain

The graph shows various score for each domain. Based on the experience G1 who has more than ten years experience shows low performance at three domains, there are Technological Knowledge (TK), Content Knowledge (CK) and Technological Pedagogical and Content Knowledge (TPACK). It shows that this teacher does not keep up with the times, even have more experience. The fact that a plausible factor can explained. This teacher has less professional development program. The teachers need proper professional development to balance content, pedagogy and technology in teaching activity. Our findings suggest to the teachers on this study to actively participated in professional development. The future design of technology-related professional development for international teachers should be informed by the constraints of resources and the school environments in which teacher are working, as success of any teacher education program is highly dependent on understanding the learners and their context (Dalal, Archambault, & Shelton, 2017).

Teacher with code G2, who has teaching experience more than five years, but less than 10 years shows a different pattern. She tends to have high score in almost all domains. But in domain PCK she has very low score. Due to lack of experience, this teacher has no time practice her teoritical knowledge of teaching. The next one is the G3 teacher, she is a new teacher. Consequently, she gains a very low score in pedagogical knowledge. Because she is a fresh graduate, so her content knowledge is better than pedagogical, and she only need practice to increase her ability to teach.

The results of the analysis showed that teacher B had lower technological knowledge than teacher G3. Teacher G3 followed technological developments and was able to learn technology easily. If it is related to the age of the teacher, this is because teacher C is still 24 years old and has less experience in teaching so that she is still very often in touch with technology. This is consistent with research conducted by Elizabeth W.B. et al (2007) which show that demographic variables such as age are variables that significantly influence attitudes and interests in technology.

Teacher G1, who is 37 years old has lower technological knowledge. It was also discussed in the study of Vaportzis E et al (2017), showing that adults have anxiety related to cost, lack of confidence and skeptical about using technology. In addition, the age factor has an influence on teacher interest in using technology (Palupi, Holillulloh, & Yanzi, 2015). Score of technological knowledge indicators show that G3 is able to learn technology easily, keep up with new technology, play with technology and has more knowledge about different technologies.

Teacher G1 has not been able to solve the technical problems she experienced herself. Although teacher G1 has more teaching experience that teacher G2 and G3, the ability to use technology still requires practice. Teacher G1 should understand information technology broadly to use it productively in the classroom, to recognize when information technology can hinder or achieve goals and continually adapt to changes in information and communication. Technological developments can be followed by joining an ICT workshop in accordance with the occupied field of study

Overall, experienced teachers have high barrier in integrating technology to their class. As we mention before that this because lack of participation in professional development. In contrast, with less experience teacher, even she has a little time to teach, but she already has more experience in using updated technology in education. Thinking about, and engaging with, advanced technologies gives teachers advantage point to examine their beliefs about, and attitudes towards, what it means for their students to be successful (Pusparini, Riandi, & Sriyati, 2017)

To support our quantitative findings, CoRe instrument was applied. Table 3 shows the ability of each teacher's TPACK based on the answers to the CoRe instrument.

Table 3. CoRe score each teacher

Item CoRe	G1	G2	G3
1	2	4	4
2	3	2	2
3	2	3	1
4	2	2	2
5	2	2	2
6	1	4	2
7	2	2	3
8	2	2	3
total:	16	21	19
Percentages	50%	65%	59%

Determination of grading for each item is based on the rubric developed by Anwar, Rustaman, Widodo, & Redjeki, (2014) The maximum value for each CoRe item is four, so that for one teacher the maximum score is 32 or a percentage of 100%. The percentage obtained by each teacher indicates that the CK category they have is still in the medium category. The observation results were reviewed from CoRe

What will you teach students about this concept?

To reach the Standart Competencies that reads: Analyzing climate change and its effects on the ecosystem. The teacher determines what materials need to be learned so that the KD is fulfilled. In global warming material, teachers want students to learn about: understanding global warming, the process of global warming, the impact of global warming and solutions to global warming problems.

Why are these concepts important for students to learn ?

The concept is considered important by the teacher because it is the basis for understanding global warming material. The teachers describe the reasons related to students' understanding of the material.

What related ideas/concepts do you think the time has not been known by students?

In the matter of global warming , the things that teachers need to know include: the process of global warming in terms of chemical reactions, the marking of the Greenhouse Effect process, the impact that disrupts the balance of the ecosystem, the process of reflecting electromagnetic waves, and the ozone layer depletion.

What difficulties/limitations might you experience to teach the concept?

The teacher was overwhelmed with a sense of concern that his students would not be able to understand teaching material well. The limitations are in the form of things related to the lack of reading material in student handbooks, lack of understanding of students' concepts, the process of global warming cannot be observed quickly, differences in concepts presented in teacher books and student books, concepts related to chemical reactions and limitations on means student infrastructure to access additional information related to global warming.

What are the conditions of students (initial knowledge/ways of thinking/interests)/what are the considerations in teaching this concept?

In teaching a material, in addition to considering curriculum demands the teacher should also pay attention to the condition of the students. Because not all students can receive the material properly but are influenced by several conditions. The conditions that are considered by the teacher to teach a concept are the students' curiosity itself, an adequate environment, learning media and other supporting facilities.

What factors are your consideration in teaching the concept?

Another factor that is considered by the teacher is to teach a concept in the form of student residence conditions, students' initial understanding of a concept and the limitations of learning media.

What sequence/path do you choose to teach the concept?

The sequence in teaching a concept can be started by teaching concrete concepts first and then to concepts that are more abstract in nature. Teachers choose to explain the process of global warming first and then the causes, then marking the ERK process. After that the impact is explained and the solution offered. The other sequence in explaining the concept of global warming is to start by showing a learning video, then simulating global warming, after that, doing an experiment to observe the global warming process and then assigning it.

How do you know that students understand or not?

To check students' understanding, the teacher conducts an assessment using tests, mind mapping assignments, performance appraisal, portfolio or by question and answer method.

The last two items of the question are components of Pedagogical knowledge (PK) because it involves the sequence of material and how to assess student knowledge. However, what remains the focus of this research is the teacher's Content Knowledge which is illustrated by the first six questions.

Content knowledge (CK) for each teacher is first described by the selection of essential concepts or big ideas of global warming material. Based on what the teacher has written, the selection of big ideas is only based on KD so that it does not explore the teacher's own knowledge about the material of global warming. Teacher's Content knowledge does not affect the attitude of the teacher in teaching it. Thus, content know;edge cannot be used to predict pedagogical content knowledge (Riandi et al, 2018). But Davidowitz & Potgieter's (2016) research shows that material knowledge is a prerequisite for designing learning designs, which are also part of PCK. Content knowledge is very important because teachers' ability to teach cannot be adequately assessed by observing their teaching without referring to the material being taught (Backman, Pearson, & Forrest, 2019).

The results of research on pedagogical knowledge content try to start knowledge pedagogy knowledge of science teachers by involving the teacher himself in designing CoRe as in this study (Adi J, 2017, Diana 2018, Hume & Berry 2010). The findings from the study indicate that with the right strategy and timing the CoRe construction process can be used to develop PCK in novice teachers. Therefore, G1 teachers as fresh graduates should be accustomed to developing CoRe on the topics to be taught so that the teacher's PCK abilities will be better.

Pedagogical knowledge of teacher content may not be directly related to teaching practice, but knowledge of pedagogical content can shape teacher teaching patterns (Widodo, 2017; Deng, 2018; Suh & Park, 2017). The research results of Diana et al (2018) show that there are several factors that influence the development of science pedagogy knowledge of science teacher content, namely the factors of teaching experience, supervision patterns, lesson study, and the teacher's relationship with students.

CONCLUSION

The prior purpose of this study is to describe the teachers TPACK based on their teahing experience and implications of this study are that experienced teachers perceived higher barriers in integrating technology in classrooms than less experienced teachers. This study suggests to teacher for actively join in professional development. Because the training equipped to integrate technology and reinforced the call to prepare, continually develop, and support teachers in upgrading their technology skills.

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