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Teachers' Anxiety and Technological Pedagogical Content Knowledge (TPACK) in Mathematics

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Abstract
Mathematics anxiety tends to be intensely concentrated and clearly reflected mathematics content knowledge, while Mathematics teaching anxiety is based on the individual's ability to teach Mathematics. Teaching in the 21st-Century era required teachers to have TPACK. TPACK is a combination of technological, pedagogical, and content knowledge. TPACK effectively understands the structure, representation, and adaptation of a topic, problem and content adapted according to the technology and abilities of teachers and presented in teaching. This study aims to: 1) describe the aspects of teachers' anxiety; 2) picture the sub-construct of TPACK; and 3) describe the relationship between teachers' anxiety and TPACK in Mathematics based on documents analysis. Studies assess that mathematics anxiety does not have a significant influence on the teachers' content knowledge. Also, mathematics teaching anxiety and pedagogical expertise have a meaningful relationship. Outstanding teaching can provide a good understanding of Mathematics with pedagogical knowledge. As well, a positive attitude towards TPACK is an indicator of knowledge that can influence mathematics anxiety. Teachers who demonstrate knowledge and a positive attitude towards mathematics will show better potential to hypotheses and build instructional design. It has a positive effect on teaching Mathematics.
Keywords: Teachers' Anxiety, Mathematical Content Knowledge, Pedagogical Knowledge, Technological Knowledge.

Introduction

Several studies investigated the relationship of mathematics anxiety and teaching mathematics anxiety to technological knowledge (Gnanamuthu & Krishnakumar, 2015; Jackson, 2017). The primary approach is to determine how mathematics anxiety can affect technological knowledge (TK). It suggested in the research on the relationship between mathematics anxiety and TK (Afshari et al., 2019). Mathematics Anxiety Rating Scale-Short Version (MARS-SV) was developed by Suinn and Winston (2003) to measure teacher Mathematics anxiety. Teachers who do not have technological pedagogical knowledge are not able to use online application shielding for Mathematics teaching. Some of the mathematics application teaching that teachers use in the classroom are GeoGebra,

Cabri, and mathematical laboratory (MathLab). It presents by Smaldino (2011), he also argues that Mathematics application should also not be used by teachers who consider its use to bring anxiety teaching Mathematics in the classroom.

Various studies provide an overview of the concerns of the Mathematics anxiety towards TPACK. Studies are evaluating that Mathematics anxiety does not have a significant influence on content knowledge (Jackson, 2017). Teachers who are proficient in using Mathematics content in the classroom feel enough to teach Mathematics as they usually do. Another reason says that the availability of applicable technology will change the purpose of teaching Mathematics itself (Awofala et al., 2017). Mathematics anxiety is closely related to low skills in understanding the concepts of Mathematics (Drijvers et al., 2015; Kafyulilo et al., 2015).

Some other studies aim to teach mathematics using some of the technology software, in line with technology in today's world of education (Smaldino, 2011) and providing teacher assistance in the construction of Mathematics in the classroom by Mathematics technology. Some applicable Mathematics lessons refer to technological pedagogical knowledge in the school, such as flipped classroom teaching and many more. However, it is not possible when teachers experienced anxiety and have low TPACK skills (Yanuarto, 2016).

This study aims to: 1) describe the aspects of teachers' anxiety; 2) picture the sub-construct of TPACK; and 3) describe the relationship between teachers' anxiety and TPACK in Mathematics based on documents analysis. Besides, the teaching of Mathematics anxiety and pedagogical knowledge has a significant relationship. Outstanding teaching can provide a good understanding of Mathematics with pedagogical knowledge (Faozieh and Pourhosein, 2018). Another case reveals that Mathematics teachers with common pedagogical knowledge (PK) have significant concerns about teaching in the classroom (Sivakova et al., 2017). Based on the study, it found that Mathematics teaching anxiety has a positive relationship to technological pedagogical knowledge (Drijvers et al., 2015; Kafyulilo et al., 2015) while Mathematical anxiety has no positive connection to content knowledge (Jackson, 2017; Awofala, 2017).

Teachers' Anxiety in Mathematics

Studies from various affective variables related to Mathematics education revealed that mathematics anxiety had become the most actively sought (Boyd et al., 2014; Matoti & Lekhu, 2016; Novak & Tassell, 2017; Ramirez et al., 2018). Mathematics anxiety is a complex construct and has been defined in a variety of ways. Uysal and Dede (2016) describe mathematics anxiety as a state of discomfort in response to situations involving Mathematical activities considered self-threatening and self-esteem.

The study of mathematics anxiety is contradictory. However, some researchers consider Mathematics anxiety as an affective variable in addition to the formation of technological, content, and pedagogical knowledge (Haciomeroglu, 2018). Gnanamuthu and Krishnakumar (2015) investigate Mathematics concerns in primary school teachers. In their study, gender and educational qualifications were contributing to mathematics anxiety. Other researchers represent mathematics anxiety as a sub-construction of attitudes towards Mathematics (Jong & Hodges, 2015). In Haciomeroglu's (2013) study on Mathematics anxiety of teacher candidates, he referred to the perspective of Mathematics as construction of various aspects that include Mathematics anxiety and teaching Mathematics anxiety. In fact, in educational research, mathematics anxiety is often

combined with broader issues, attitudes towards Mathematics, and attitudes toward teaching Mathematics in the classroom (Haciomeroglu, 2018; Uysal & Dede, 2016).

Also, to develop a comprehensive understanding of teachers' concerns, it is necessary to explore research that examines their anxiety factors. Gender factors are considered a cause for concern. Many studies stated that men have a more substantial Mathematical background (Gnanamuthu & Krishnakumar, 2015). Therefore, women who take Mathematics courses are considered weaker than male students. This weakness is deemed to cause Mathematics anxiety. According to Puteh (2016), women often change their educational careers if Mathematics plays a significant role in course selection. Moreover, in general, researchers agree that more research is needed for Mathematics anxiety in cognitive activities to analyze both affective and cognitive components (Leary, Fitzpatrick, & Hallett, 2017). In contrast, the cause of teaching mathematics anxiety is seen in affective activities to analyze cognitive and affective components (Novak & Tassell, 2017).

While the findings found that primary school teachers with high teaching Mathematics anxiety tend to encourage dependence, such as teachers as the primary source of information (Alkan, 2013), teaching Mathematics anxiety often uses its teaching statically and does not use teaching innovations such as models of Mathematics in their education (Leary et al., 2017). However, effective teaching of Mathematics for students is usually taught by teachers who have low teaching mathematics anxiety (Mji and Arigbabu, 2012).

According to Filippatou et al. (2016), teaching mathematics anxiety is based on the ability of individuals to teach Mathematics. Simultaneously, Mathematics anxiety tends to be intensely focused and reflects a lack of mathematics content knowledge. Also, teaching mathematics anxiety focuses on externally and reflects teachers engage students in teaching Mathematics (Moustafa, Tindle, Ansari, Doyle, & Hewedi, 2017). Similarly, Leary et al. (2017), teachers who have low mathematics anxiety will also have intense teaching mathematics anxiety. Therefore, this decision has important implications for teachers, not only for teachers who are experiencing mathematics anxiety but also support teachers who have teaching mathematics anxiety.

TPACK in Mathematics

With the emergence of technology in daily life and education in the current era of technology, we have begun to address the impact of teachers' technology knowledge. While some researchers have started to see the crossroads of pedagogy and technology in the development of non-content specific knowledge domains such as technological pedagogical knowledge (Maesuri et al. 2016), others have examined the crossroads of pedagogy and technology in the development of TPACK (Koehler et al., 2014).

TPACK introduced by Koehler et al. (2014) and today is still being studied and gives different concepts among researchers. The study of TPACK is conducted in various forms of approach and viewed from multiple perspectives (Rahmany, Sadeghi, & Chegini, 2017). Kleickmann et al. (2013) identified the components of TPACK in mathematics as a priority for teachers, pedagogy for teaching, the use of technology in education, and content in mathematics.

TPACK is a combination of technological knowledge, pedagogical knowledge, and content knowledge. TPACK is useful in understanding the structure, representation, and adaptation of a topic. Besides, TPACK is adapted according to the interests, technology, and abilities of teachers and presented in teaching (Koehler et al., 2014). Pedagogical content knowledge (PCK) refers to concepts,

procedures, misconceptions, types of understandings, mastery assessment techniques, and conceptual understanding (Aoibhinn, 2016). Meanwhile, the effectiveness of teaching Mathematics requires the skills to provide continuous and varied training, enrichment activities, classroom management, evaluate Mathematics materials, and curriculum (Dapaepe, Verschaffel, & Kelchtermans, 2013).

According to the constructivist view, technological content knowledge (TCK) is actively construct by teachers and students (Sonia, 2016). To understand how PCK incorporated into technology, teachers must-have components of pedagogical technology concepts (Aoibhinn, 2016). The use of technology software is part of technological knowledge (TK) in the teaching of Mathematics, such as Inquisit 4 Web OSAN (Durdu & Dag, 2017). The technology allows teachers to complete tasks independently from testing and calculating their scores and the various time required to solve Mathematics problems.

PCK introduce by Shulman (1986). Through the model Shulman (1986), to provide effective teaching, teachers need to be an expert. In other words, teachers need to know what to teach and how to teach. Therefore, Shulman (1986) stressed that teachers need to master two components of knowledge; content knowledge (CK) and pedagogical knowledge (PK). CK refers to the understanding of the curriculum, content, and learning outcomes of a subject. Meanwhile, PK is related to approaches and techniques to convey the content of the issue. Previous studies have demonstrated the need for teachers to have CK and PK in ensuring effective teaching (Booker, 2017; Dapaepe et al., 2013).

While technological content knowledge (TCK) refers to the ability of teachers to make connections between the topics of Mathematics to technology (Fu, 2019), TCK is also a category used to differentiate the understanding characteristics of a Mathematical content expert from a technology expert (Yigit, 2014). Teachers with good TCK can produce productive questions in the classroom (Valtonen et al., 2019). TCK is practical knowledge for teaching by combining content and technology. TCK includes effective technology planning procedures, practices in Mathematics classrooms, classroom management techniques, and variations in mathematics technology (Kim 2018).

Meanwhile, technological pedagogical knowledge (TPK) is one aspect of TPACK. TPK encompasses curriculum knowledge, including the selection and use of appropriate materials for use in the curriculum. Also, TPK refers to knowing how teachers think, teaching technology preparation, and mastering all forms of teaching technology delivery methods. TPK represents technological formulations that applied in teaching (Galleto, 2018). TPK must contain teachers' pedagogy knowledge, classroom teaching strategies, effective use of technology, and technological understanding (Malubay & Daguplo, 2018).

Teachers' Anxiety and TPACK in Mathematics

Booker (2017) conducted a mixed-method study to investigate the relationship of TPACK in the use of their technology in schools with the concerns they have. He found that teachers are rich in TPACK and had low mathematics anxiety was used to prepare lessons and for student-centered teaching. It may be consistent with Dogan (2012) description that TPACK is closely related to anxiety. Teachers should have good CK and the content of the Mathematics curriculum to implement teaching strategies in the classroom. But, the challenge of education in the current era by using technology can control the concerns of teachers. A study from Palak and Walls (2009) found that the use of

technology for teachers to support teaching using technology even though some teachers have low teaching anxiety. So, it affects that there is a relationship between TPACK and the concerns of teachers' anxiety.

Although the review of the study found that many barriers to TPACK in the use of Mathematics teaching technology do not have a good effect on teachers' anxiety, but a survey from Judson (2014) explores the close relationship between TPACK, especially in teaching mathematics anxiety. Moreover, other studies explain that TPACK systems have the most significant impact on teaching mathematics anxiety (Bick-har, 2016). Similarly, teachers combining teaching and technological innovation are highly dependent on the low anxiety of their education (Eickelmann & Vennemann 2017).

According to Voogt et al. (2020) a positive attitude towards TPACK is an indicator of the knowledge that can influence anxiety. The teachers who have a positive attitude towards knowledge and low anxiety will show better potential to build instructional design. Also, it has a positive effect on the right attitude towards Mathematics. Wilson (2018) positive thinking and feelings towards Mathematics will have a positive impact on Mathematical knowledge, teaching based on TPACK, and promoting technology in the classroom. This attitude will undoubtedly reduce the anxiety of Mathematics in teachers. In general, a positive attitude towards TPACK tends to encourage teachers to implement three basic processes of knowledge; Mathematical content, pedagogy, and technology (Fu 2019). Thus, TPACK has a positive effect on reducing teachers' anxiety.

Investigations into TPACK of Mathematics anxiety are not always permanent. As can be obtained from the study of Papanikolaou et al. (2017), the relationship between TPACK with the concerns of secondary school Mathematics teachers' anxiety in Japan is not significant. It means that the higher education background of Mathematics teachers does not give a picture of teachers' anxiety. The teaching of Mathematics in Japan emphasizes the use of technology over traditional instruction. Teaching does not depend on the high level of teachers' education and the level of anxiety. Other research results show that contradicted, Carrillo et al. (2018), working around the teaching of Mathematics is generated from using technology in the classroom. The learning of Mathematics using technology encourages teachers to learn how to use Mathematical research and TPACK. They accept changes in teachers' attitudes towards Mathematics and the low level of teachers' anxiety produced.

Furthermore, the findings of the study from the relationship of TPACK with anxiety in Indonesia and Malaysia, as investigated by Yuniarti and Pang (2014) say that Mathematics teachers who have a low level of anxiety will apply teaching based on constructivism. This teaching will be better when the teacher has better TPACK. Their results found that teachers with a high level of TPACK are more open in providing any questions and opportunities for students to ask about the goals of Mathematics content in the classroom.

Conclusion

Studies assess that mathematics anxiety does not have a significant relationship with TPACK issues. Teachers who use mathematics content feel it is enough to teach Mathematics as they usually do. Another reason to say that the availability of applicable technology will change the purpose of teaching Mathematics itself. Also, Teaching mathematics anxiety and TPACK have a significant relationship. Outstanding teaching can provide a good understanding of Mathematics with TPACK. They were providing goals for the effective teaching of Mathematics using some of the advanced

technologies. Therefore, the role of technology useful for use in face to face teaching or online learning. However, the advanced technology used in the classroom is not possible when teachers have low TPACK performance and experienced teaching mathematics anxiety. Thus, a positive attitude towards TPACK is an indicator of knowledge that can influence teachers' anxiety. It has a positive effect on thinking and feeling towards Mathematics.

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