



Technological Pedagogical and Content Knowledge (TPACK) of Special Education Teachers in Science Instruction for Students with Special Needs

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Abstract

Integration of technology in science instruction in special education context can be implemented within the technological, pedagogical, and content knowledge (TPACK) framework. Therefore, special education teachers are expected to have a good level of TPACK. This study aimed to explore the level of teachers TPACK in science instruction for students with special needs. This research also was addressed to compare the TPACK level of teachers based on their gender. This research used a quantitative approach with survey method. The respondents of this study were special education teachers (N= 44). The data collection method was through a survey using the TPACK survey instrument. The validation result used the Pearson Correlation showed value per statement ranging from 0.504 - 0.904. Reliability showed in the Cronbach's coefficient Alpha for internal consistency value of 0.856 (high). The data analysis technique used was the descriptive statistical analysis technique and the independent sample t test. The results showed that each TPACK domain for both gender was in a very good and good category. Female teachers were seen to be superior in most of the domains. This research also found that there was no difference of the TPACK level between male and female teacher. The issue of gender equality that has begun to be implemented in Indonesia and the ease of access to technological knowledge can be the reason for the loss of technological mastery differences. In conclusion, there was no difference of the TPACK level in science instruction between male and female special education teacher.

Keywords: TPACK, science instruction, special education teacher

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INTRODUCTION

Student with special needs are children who experience difficulties in learning as well as those whose performance is so advanced that modifications in curriculum and instruction are necessary to help them fulfill their potential (Heward, Alber-Morgan, & Konrad, 2016). The number of students with special needs in Indonesia keeps increasing year by year. In 2018, The Indonesia Ministry of Education and Culture reported that they were 133.826 students with special needs in Indonesia (Ministry of Education and Culture, 2018). This number is higher than the previous year amounted 128.510 students (Ministry of Education and Culture, 2017).

Science is an important subject in the general education curriculum. Science education not only makes students' progress academically but also socially by enhancing their interpretation and exploration of their environment (Ozguç & Cavkaytar, 2015). For

students with special needs, the science curriculum provided is usually limited according to students' abilities (Karvonen et al., 2011) and the methods used in science instruction are also different (Browder et al., 2014). The difference in methods in delivering science material is carried out considering that students with special needs need adjustments or modifications in learning. On the other hand, teaching science to students with special needs is a challenge, considering their learning characteristics.

Teachers and researchers have tried several ways to help students with special needs in science instruction, including the use of technology. For typical students, computer-based learning has a significant effect on student independence in science learning (Aditama & Sadhu, 2019). This also applies to students with special needs. For students with special needs, utilizing technology including computers to deliver learning materials through interactive images, videos, animations, and games, makes computers an independent support for students and teachers (Hew & Cheung, 2010; Rutten, van Joolingen, & van der Veen, 2012). This is because technology integrates color, sound and computer images which can improve students' understanding (Chai, Vail & Ayres, 2014).

Technology can be integrated in learning through the Technological Pedagogical and Content Knowledge (TPACK) framework. TPACK is a combination of three knowledge domains, namely content, pedagogy, and technology in teaching. The TPACK framework is built on the PCK (pedagogical and content knowledge) description explained by Shulman (1986) and how teachers' understanding of technology in education to produce effective teaching with technology (Koehler, Mishra, & Cain 2013; Schmidt et al., 2009). Equally important for this model is the interaction between and among these domains of knowledge, represented as PCK, TCK (technology and content knowledge), TPK (technology pedagogical knowledge), and TPACK. The following is an explanation of each component (Koehler, Mishra, & Cain, 2013; Schmidt et al., 2009).

Table 1. TPACK Domain

TPACK Domain	Definition
Content Knowledge (CK)	Teachers' knowledge of the subject matter to be studied or taught.
Pedagogical Knowledge (PK)	Teachers' in-depth knowledge of the processes and practices or methods of teaching and learning
Technological Knowledge (TK)	Knowledge of various technologies, ranging from low technology and digital technologies such as the internet, digital video, and software programs.
Pedagogical and Content Knowledge (PCK)	Content knowledge related to the teaching process. This domain combines content and pedagogy to develop better teaching practices in the content area.
Technological and Content Knowledge (TCK)	Technology refers to knowledge of how technology can create new representations for certain content.
Technological Pedagogical Knowledge (TPK)	Knowledge of how various technologies can be used in teaching
Technological Pedagogical and Content Knowledge (TPACK)	Knowledge needed by teachers to integrate technology into their teaching in any content area they teach.

In Indonesia, teachers have obligation to increase their competencies, including in science, technology, and art skills (Law Number 14 of 2005 on Teachers and Lecturers). Furthermore, the benefits of using technology in the learning process of students with special needs (Chai, Vail & Ayres, 2014; Hew & Cheung, 2010; Rutten, van Joolingen &

van der Veen, 2012) make teachers have to master the use of technology. Therefore, teachers need to master technological skills to increase their competencies and create a good instruction for the students. In Indonesia, research on TPACK has begun to be widely carried out. In the field of natural science, Suryawati, Linggarsi, and Arnentis (2017) studied the TPACK of biology prospective teachers. However, most of these studies are not in the special education context. In fact, research on TPACK in the field of special education has been carried out in many countries (Demirok & Baglama, 2018; Huang, Chen & Jang, 2020; Lyublinskaya & Tournaki, 2014). For this reason, it is also needed to measure the level of TPACK of special education teachers in Indonesia.

There are factors that influence the implementation of the TPACK framework, including teachers. Teachers' TPACK is complex since it is influenced by many factors such as differences in characteristics that affect the learning process to be carried out (Astuti et al., 2019). Teacher personality factors can also influence teaching methods, including gender, age, teaching experience, character, and beliefs (Cruickshank et al., 2012). Several studies have shown that gender is a factor affecting teacher TPACK and there is a significant difference in TPACK against teacher gender, in which men have a higher TPACK than women (Lin et al., 2013; Liu, Zhang, & Wang, 2015). Even so, Astuti et al., (2019) found that there was no difference in the TPACK level between male and female teachers. The different results on the influence of gender on TPACK needed to be studied more deeply especially in special education context. The dominance of the TPACK ability of male teachers indicated a critical situation for special education since most of the teachers in special education are women (Ministry of Education and Culture, 2018). If they have low TPACK level, it is possible that teachers' technological competence in special education is also low.

TPACK is influenced by many factors, in which gender is one factor that remains unclear. Some studies said that women's TPACK is lower which can affect their competence in teaching and integrating technology into their instruction. Whereas the field of special education in Indonesia is dominated by female teachers. The data from the Ministry of Education and Culture from 2016 to 2018 showed that the number of female special education teachers was higher than male teachers. In 2016, there were 17,355 female teachers and 7,302 male teachers. Meanwhile, in 2017 there were 17,630 female teachers and 6,704 male teachers. The latest data in 2018 reported that there were 19,259 female teachers and only 7,620 male teachers. Based on data from year over year, it can be seen that nationally the proportion of female teachers is always growing. Whereas in Yogyakarta in 2017, there were 865 female teachers and 358 male teachers (Ministry of Education and Culture, 2017).

The gender issue might be the reason for difference in technological knowledge between male and female. In Asia, including in Indonesian culture, men still hold the leading role in many aspects of life. This male-dominated social structure is called patriarchy (Dewi, 2019). Recently, technology is always associated with male, although technology is very useful and helpful for both males and females living in the era of globalization (Suwana & Lily, 2017). Gender equality in technology is hard to be accomplish since a gender mainstreaming policy has still not been properly implemented in Indonesia (Wakhidah, 2012). For example, a study done by Latif et al., (2019) found that there is a significant influence between teacher gender and ICT literacy in Indonesia. This means, in general, gender still has a significant influence on mastery of ICT in Indonesia.

Observing the increasing number of children with special needs in Indonesia and the importance of science education for students with special needs as well as opportunities to use technology within the TPACK framework, it is necessary to conduct preliminary research. Given that the number of female teachers in the context of special

education is more than male teachers and patriarchal culture in Indonesia, it is necessary to conduct research to find out for sure. Therefore, this study aimed to determine the TPACK level of special education teachers in science instruction. This study also aimed to compare the TPACK level of special education teachers in science instruction based on their gender.

METHODS

This study used a quantitative approach while the type of research was a survey research. Therefore, the data collection was done by using a survey method. This survey was conducted within three weeks from December 9th until 30th 2020. The population of this study is special education teacher in Yogyakarta City. The respondents of this study were special education teachers both in inclusive schools and in special schools with total $n = 44$. The sample of this study were selected using the convenience sampling technique as it is readily available and simple to implement. The characteristics of respondents dominated by teachers of student with special needs who have been teaching for at least 1 year and have a bachelor's degree in special education. The demographic data of the research participant is presented in the table 2.

Table 2. Demographic Data of Research Participants

Construct	Category	Frequency	Percentage
Gender	Female	27	61.4 %
	Male	17	38.6 %
Age	21- 25	27	61.4 %
	26- 30	11	25 %
	31- 35	3	6.8 %
	36- 40	-	-
	>40	3	6.8 %
Seniority	1-2 years	21	47.7 %
	3-4 years	15	34.1 %
	5-6 years	3	6.8 %
	>6 years	5	11.4 %

The data were collected through the Technological, Pedagogical, and Content Knowledge Questionnaire which was developed and validated by Desstya (2018). The questionnaire was sent to the participants via Google Form. It consists of 29 items about TPACK on a 4-point Likert scale. Examples of instrument items include “*I can make a PowerPoint Presentation to show / explain the concept of science material*” and “*I understand how to use ICT media to develop lesson plans*”. TPACK model 29 statements in the questionnaire are divided into statements about TK (6 items), PK (4 items), CK (4 items), PCK (5 items), TCK (4 items), TPK (3 items) and TPACK (3 items). Every item in the questionnaire is four Likert scale. Likert scale question comprised four points ranking following: “strongly agree” (4 points), “agree” (3 points), “disagree” (2 points), “strongly disagree” (1 point). The instrument validation result done by Desstya (2018) used the Pearson Correlation showed value per statement ranging from 0.504 - 0.904. Reliability showed in the Cronbach's coefficient Alpha for internal consistency value of 0.856 (high).

Data analysis was carried out with descriptive statistics and t test to compare the level of TPACK of the special education teachers. Descriptive analysis was carried out to

see the TPACK level of teachers in each domain by representing and interpreting data categories using Arikunto's (2011) categorization. First, the data is processed from the raw scores to the fine scores with the following formula:

$$P = \frac{f}{N} \times 100$$

P = value
F = obtained value
N = maximum value

The fine scores obtained were then entered into the categorization table. Researchers used categorization table from Arikunto (2011). This categorization is divided into five categories with the TPACK mastery criteria presented as follows:

Table 3. Teachers TPACK Level Category

Value	Category
84- 100	Very good
68- 83	Good
52- 67	Enough
36- 51	Low
≤ 35	Very low

RESULTS & DISCUSSION

Results

This research was conducted through a survey method. The researchers used the google form platform to collect data. After the online instrument was created, a link was sent to the respondents. After collecting the survey data from 44 respondents, the researcher obtained information about the level of TPACK for special education teachers in science instruction for students with special needs. First, descriptive analysis was carried out to determine the level of TPACK at the teacher level which is divided into seven TPACK domains which can be seen in the following table.

Table 4. Teachers' TPACK Level

TPACK Domain	Male			Female		
	Mean	SD	Category	Mean	SD	Category
TK	89.95	12.85	Very good	90.28	8.95	Very good
PK	84.87	17.29	Very good	84.92	13.48	Very good
CK	75.00	15.78	Good	75.23	10.89	Good
PCK	73.90	14.70	Good	76.16	9.34	Good
TCK	84.56	16.26	Very good	84.26	10.01	Very good
TPK	84.80	15.93	Very good	83.64	10.96	Very good
TPACK	75.00	16.40	Good	76.54	9.82	Good

In general, it can be seen that each domain in both genders is included in the very good and good category. In addition, each domain of the two groups of participants also fell into the same category. Female teachers are seen to be superior in the TK, PK, CK,

PCK, and TPACK domains. Meanwhile, male teachers were only slightly superior in the TCK and TPK domains.

TK is seen as the domain with the highest score in both male and female teachers (89.95 and 90.29 respectively) which mean teachers seem to have a high level of technological knowledge. The difference in TK scores in the two groups of participants was also relatively small. Furthermore, PK is seen to be the second ranked domain in both groups. For male teachers, PCK was the domain with the lowest score (73.90). Whereas for female teachers, the domain with the lowest score was CK (75.23). Based on the table, it can be seen that the domains related to content knowledge tend to have a lower mean value compared to other domains. CK indicates teachers' knowledge of the science subject matter to be studied or taught. Even though it is in the good category, this needs to be known. That is, teachers tend to think that they have low content knowledge in science subjects.

The next analysis was carried out to determine whether there is a difference in the level TPACK of teachers based on gender. The TPACK level were compared with an independent sample t-test. The results of TPACK level analysis based on gender are presented in the following table.

Table 5. Comparison of Teachers' TPACK based on Gender

Gender	n	mean	SD	t	p
Female	27	81.44	7.37	0.123	0.90
Male	17	81.03	12.58		

$P < 0.05$

Since the data is normally distributed, the t-test which is a statistic parametric was applied in order to determine whether TPACK levels of special education teachers significantly differ based on their gender. Table 5. demonstrates t-test results on gender and TPACK levels of special education teachers. As it can be seen, TPACK levels of special education teachers do not show significant difference based on their gender. The mean scores between the two groups, shows there are no significant different. Based on the results of calculations that have been done, the t value obtained was amounted 0.123.

The t value in the t table with a significance level of 0.05 indicated the value of $t = 2,085$. Furthermore, the t value obtained was compared to the critical t value in the t table. When compared, it can be seen that the t value (0.123) is less than the critical t value in the t table (2.085). Therefore, H_0 is accepted. Hypothesis testing using the p value also shows the same results. The p value obtained was 0.90. Using a comparison of p value 0.05, it can be seen that $0.90 > 0.05$, so that H_0 is accepted. With H_0 accepted in each domain, it can be concluded that there is no difference in the TPACK level of the teachers based on their gender. In other words, there was no difference of the TPACK level in science instruction between male and female special education teacher.

Discussion

This study aimed to explore the TPACK level of special education teachers in science instruction for students with special needs and to compare the level of TPACK of teachers based on their gender. This study found that each domain for both genders is included in a very good category and good category. The TPACK domain for both males and females also showed in good category. These findings are in line with the study done by Demirok and Baglama (2018) which found that TPACK levels of special education teachers is high. Other studies also showed the same findings (Huang, Chen, & Jang (2020); Mai & Hamzah, 2016). These similar research results support the finding of the

present study. This result was obtained as most of the respondents are young teachers, who make them more familiar with the use and integration of technology into their instruction. On the other hand, teachers with elder age may have less technological knowledge. This statement is reinforced by the opinion of Liang et al., (2013) who reported that teachers with older age tend to have less technological knowledge and ICT integration so that they can have moderate barriers to implementing technology in the learning environment.

Comparing both genders, female teachers seemed more advanced in most of the domain (TK, PK, CK, PCK, and TPACK). Whereas male teachers only slightly superior in TCK and TPK domain. This means that female teachers in special education showed better competence in TPACK compared to male teachers. The previous findings (Lin et al., 2013; Liu, Zhang, & Wang, 2015) stated that men are more likely to excel in technological abilities. However, the results of this study showed that female teacher are more superior in most domain of TPACK.

TK was the domain with the highest mean score in both male and female teachers. The same finding also found by Mai and Hamzah (2016) which found the TK score was higher than the other TPACK subscales. The abundance of information that can be accessed online about how to integrate technology in learning may improve teacher's knowledge. Nowadays, web-based professional development programs are increasingly popular so that teachers can learn independently to increase the knowledge of technology needed in their instruction they might need (Liang et al., 2013). Therefore, it is possible that the level of technology mastery has increased.

This study also found that for male teachers, the domain with the lowest score was PCK. Meanwhile, CK was the lowest mean value for female teachers compared to other domains. Therefore, it can be concluded that the domains related to content knowledge tend to have lower mean value compared to other domains. This means teachers feel that they have lower abilities in mastering learning material in science subjects. However, this finding contradicted with the previous studies such as a study done by Peng and Daud (2016) which found that special schoolteachers showed high CK level. This means that there is still uncertainty regarding the level of CK in special education teachers especially in science instruction. Therefore, further research needs to be done.

The comparative t-test in the study showed that there was no difference in the TPACK level between teachers based on their gender. This results in accordance with some research that showed no significant gender influence on TPACK (Astuti et al., 2019; Demirok & Baglama, 2018; Hsu & Chen, 2018; Mai & Hamzah, 2016). These findings, however, contradict with the previous opinion by Latif et al., (2019) which stated that male teachers know more and do better work using ICT devices than female. More specifically some research found that men have a higher TPACK than women (Lin et al., 2013; Liu, Zhang, & Wang, 2015).

The issue of gender equality that has begun to be implemented in Indonesia could be the reason for the loss of technological differences between men and women in technological mastery. In 2012, Wakhidah stated that gender equality in technology is hard to be accomplish because a gender mainstreaming policy has still not been properly implemented. However, along with the time, the issue of gender equality is increasingly becoming a concern and being implemented. Women's groups or the community have become a target for digital literacy programs for the country. For example, Suwana and Lily (2017) did an interview to Indonesia's Deputy Minister of Women's Empowerment and Child Protection for Gender Mainstreaming in the Economy, Sulikanti Agusni, who argued that the internet gives chances for mothers or housewives to become entrepreneurs. Therefore, they can produce additional income for households. With the

decreasing issue of gender differences in technology, the level of mastery of technology for male and female teachers is no longer different.

Another reason that can contribute to the loss of differences in technology mastery between men and women is the ease of access to technological knowledge. For example, Liang et al., (2013) stated that web-based professional development programs are increasingly popular which made teachers can learn independently to increase the knowledge of technology they might need in their instruction. They can easily access to increase their competencies via online. This is, of course, make it easier for men and women to acquire technological knowledge. As a consequence, this can also reduce the gap in technology mastery between men and women.

CONCLUSION

In conclusion, this study found that each domain for both genders is included in a very good category and good category. Female teachers were seen to be superior in most of the domains. The TK was the domain with the highest mean value in both male and female teachers. It was because most of the respondents are young teachers who make them more familiar with technology. The domains related to content knowledge tend to have lower mean values. The comparative t-test in the study showed that there was no difference in the TPACK level between teachers based on their gender. This means that teachers' TPACK level is not differentiated by their gender. The issue of gender equality that has begun to be implemented in Indonesia and the ease of access to technological knowledge can be the reasons for the loss of differences in technological mastery abilities between men and women. This research still has limitations due to the relatively small number of respondents in survey research. Therefore, further research should be done with more data and heterogeneous samples to increase the generality of study result. Thus, decisions can be made regarding the use of the TPACK framework in science learning for students with special needs.

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