TPACK Mastery of Biology Teachers: A Study Based on Teacher Gender

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Abstract. TPACK is knowledge that needs to be mastered by teachers to be able to integrate technology in the learning process. The success of integrating ICT can be influenced by teacher gender. Differences in character between male and female teachers can influence teacher’s steps and ways to teach to integrate technology in learning. This study aimed to know TPACK mastery of biology teacher and how it differs between male and female biology teachers. This study involved 29 biology teacher respondents who were taken using the convenience sampling of the hypothetical population. Data collection is conducted using a test instrument consisting of 40 items. Instruments meet the logical validity test based on expert judgment. The empirical validity showed infit MNSQ 1.00 invitations and standard deviation of 0.16 which means all items were valid. Test instrument reliability results of 0.57 means that test was good enough to provide consistent measurement results. The data were analysed descriptively and inferentially through the independent sample t-test. The results of this study showed teacher TPACK mastery was good with a score of 59.15 but TK domain with score of 46.67 and TPACK domain with score of 45.83 were still fair. TPACK mastery of biology teacher was not differentiated by teacher gender with p>0.05.

1. Introduction
The 21st century was marked by the rapid development of information and communication technology (ICT). The development of technology has an impact on all sectors of life, one of which is the education sector. Teachers as key in education need to pay attention to this development. Professional teachers will always develop themselves along with the development of the times in accordance with the 2005 Constitution No. 14 concerning Teachers and Lecturers stating that teachers are obliged to improve and develop academic qualifications and competencies on an ongoing basis. This is in line with the development of science, technology, and art. Therefore, teachers need to master ICT therefore that learning is in line with current developments. ICT mastery is needed by teachers to be able to integrate technology in learning according to the demands of 21st-century education.

To be able to integrate ICT in the learning process, teachers must master the knowledge of technology that is integrated with pedagogical and content knowledge. The integration of pedagogic, content, and technology knowledge in order to realize ICT-integrated learning is called Technological Pedagogical and Content Knowledge (TPACK) [1]. Good teaching with technology requires at least three domains, namely Pedagogical Knowledge (PK), Content Knowledge (CK), and Technological Knowledge (TK) as well as relationships between these domains. The three are interconnected to form the Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK),
Technological Content Knowledge (TCK), and Technological Pedagogical and Content Knowledge (TPACK).

The TPACK mastery of teacher need to be aware to see the teacher's readiness in integrating ICT in learning. Teachers who master TPACK will have a great potential to successfully integrate ICT in the learning process. Teachers could not integrate ICT if teacher did not have a good enough knowledge on integrating ICT in the learning process. TPACK's mastery of biology teachers has not been measured especially in Yogyakarta city. Yogyakarta City as a barometer for other areas of education quality issues. Thus the mastery of TPACK of biology teachers in Yogyakarta becomes more urgent, because it will be able to provide reference information for biological learning in other regions in Indonesia. The teacher assessment that has been done is that UKG (Uji Kompetensi Guru) and PKG (Penilaian Kinerja Guru). This assessment measure teacher pedagogic and professional knowledge but have not measured the teacher's knowledge of technology and its integration in pedagogic and content. Some research has been conducted measuring the TPACK mastery using an instrument with attitude scale. Whereas TPACK is a knowledge therefore the appropriate measuring instruments use test. Therefore, research surveys need to be conducted to know the mastery of TPACK biology teachers using test instruments.

Teacher TPACK are very complex because they are influenced by many factors. Each teacher has different characteristics that influence the learning process that will be carried out. The teacher’s personality can influence teacher teaching methods including gender, age, teaching experience, character, and beliefs [2]. Gender was one of the factors that could influence the teacher’s TPACK mastery. Differences in characteristics, attitudes, and abilities by male and female teachers could influence teacher mastery of teacher TPACK. Research into the influence of gender on TPACK has been carried out in several countries and shows diverse results. Some studies show gender was a factor that influences teacher TPACK and there were significant differences in TPACK towards teacher gender where male have higher TPACK than female [3, 4, 5, 6]. This is due to the male's knowledge of ICT better than female [7]. Different ICT knowledge between male and female can affect the mastery of TPACK. This difference in results showed gender influences and the TPACK teachers need to be further examined. Some studies show the opposite results where there was no significant gender influence on TPACK [8, 9, 10, 11]. The difference in results caused the influence of gender to be studied more deeply. results of the study showed that female teachers were less interested in using ICT [12], male were more experienced with ICT [13, 14]. The research above showed differences in the characteristics of male and female teachers could influence the integration of ICT in learning. Gender influences the adoption of ICT in learning activities [15]. The level of success of the integration of ICT in learning could be reflected in TPACK therefore that if the teacher was able to apply ICT in learning then had a high TPACK.

Male teacher were more confident in ICT but female teachers were more confident in the pedagogical knowledge [16]. Male and female teacher had different type in teaching. Some research results show there are differences in the teaching characteristics of female and male teachers. Female teachers are more interactive, providing support and motivation to learners and expressive [17], more guiding [18], more open to learners [19], more interaction and collaboration with learners [20], and using more flexible learning methods [19]. Male teachers tend to dominate more in teaching [19], more emphasizing group learning and structured activities [19], actively asking short questions to student [17], and more authoritarian teaching styles [20].

According mastery of biological content, some research shows female have more mastery biology content than male [21, 22]. Female have a higher recall ability than male because female have a wider hippocampus therefore as to potentially improve better long-term storage memory than male [23]. Biology were many concepts that must be memorized very supportive for female.

In Indonesia, technology is still seen as a task of male. Male were more trusted in technical tasks related to technology while female were still underestimated [24]. The results of other studies by the State Ministry of Empowerment of Indonesian Women, in the field of technology, especially ICT, obtained results that information and communication technology was still very close to male’s
identities. One of the factors that influence this condition was value and culture. In Indonesia, the existence of a patriarchal culture that marginalizes female had an impact on the use of technology. Technology was not free of values or culture, meaning the level of use of technology was influenced by culture and user value [25]. The value of technology tended to be more masculine than feminine which was one of the causes of technological inequality between male and female. The cause of the low involvement of female in the ICT field was the socio-cultural construction which emphasizes the ICT field was the domain of male [26, 27]. In addition, variables that cause ICT integration were slow in the curriculum, namely teacher factors, one of which was due to the influence of gender aspects [20]. Therefore, this research was important to determine whether there was an influence of gender on the TPACK mastery of biology teacher.

2. Method
This type of research was survey research. This research was conducted from September 2018 – March 2019 in 20 high schools in Yogyakarta City, Indonesia. The population of this research was hypothetical population of all biology teacher in public and private high school in Yogyakarta city. The sample of this study amounted to 29 biology teachers who were selected using the convenience sampling technique. Characteristics of respondents dominated by teachers who have been teaching more than 15 years, certified, and bachelor degree of biological education. This research is not conducted by strict variable control. Data collection instruments used tests. Test instruments in the form of multiple-choice test amounted to 40 items. The indicator of teacher TPACK mastery were presented as follows.

| TPACK Domain | Indicator | Items |
|--------------|-----------|-------|
| PK | Teacher understand students' character, learning theory, learning strategies, and learning planning | 6 |
| CK | Teacher understand biology subject (i.e. bacterial, plantae, digestive system, respiration system, excretion system, immune system, metabolism, genetics, and biotechnology). | 10 |
| TK | Teacher understand various technological elements include ICT-based media, blogs, email, educational websites, and Internet-based search engines | 4 |
| PCK | Teacher understand how to adjust biology subject with learning approaches, models, methods, learning media, student characteristics, and assessment | 6 |
| TCK | Teacher understand how to adjust biology subject with ICT | 5 |
| TPK | Teacher understand how to adjust ICT with approaches, models, methods, and learning media | 5 |
| TPACK | Teachers' understanding of ICT, learning strategies, and learning materials are adjusted to the students' characters | 4 |
| | Total | 40 |

The instrument used had fulfilled validity and reliability. The logical validity of the test instrument was done through expert judgment and empirical validity obtained from the results of the quest test with the results of all items fit with MNSQ 1.00 invitations and standard deviation of 0.16, meaning all items were in accordance with the Rasch model. Test instrument reliability results of 0.57 means that the reliability of the test is good enough to provide consistent measurement results.

Data analysis of this study was carried out descriptively and inferentially through the independent sample t-test. The results of the scores obtained are converted into values using the following formula.

\[ P = \frac{f}{N} \times 100 \]
Description:
P = values
F = obtained score
N = maximum score

The values gained was then compared to the TPACK criteria [28]. The criteria of TPACK mastery presented as follows.

| Table 2. Biology Teacher’s TPACK Mastery |
|-----------------------------------------|
| Values       | Criteria    |
|----------------|-------------|
| 84-100        | Excellent   |
| 68-83         | Very good   |
| 52-67         | Good        |
| 36-51         | Fair        |
| ≤ 35          | Poor        |

3. Result

Teacher TPACK were obtained through test results. Data obtained were profile of TPACK mastery of biology teachers in Yogyakarta city, Indonesia and TPACK mastery difference by teacher gender. Gender teachers were consisted of male and female teachers. The data of research were presented as follows.

3.1. Profile of TPACK Biology Teacher

TPACK mastery consist pedagogical knowledge (PK), content knowledge (CK), technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical and content knowledge (TPACK). Profile of TPACK mastery of biology teacher in Yogyakarta city was showed as follows.

Table 3. Biology Teacher’s TPACK Mastery

| TPACK Domain | Mean  | Standard Deviation | Criteria    |
|--------------|-------|--------------------|-------------|
| PK           | 72.22 | 18.22              | Very good   |
| CK           | 72.67 | 13.48              | Very good   |
| TK           | 46.67 | 22.49              | Fair        |
| PCK          | 53.33 | 15.41              | Good        |
| TCK          | 54.67 | 18.14              | Good        |
| TPK          | 68.67 | 22.09              | Very good   |
| TPACK        | 45.83 | 26.33              | Fair        |
| Total Average| 59.15 | 19.45              | Good        |

Based on the test results, the average mastery of TPACK teachers obtained a score of 59.15 with good criteria. Teachers of biology have mastered the knowledge of PK, CK, PCK, TCK, and TPK well but the domain of TK with score of 46.67 and TPACK with score of 45.83 was still fair. These results showed that teachers still lack knowledge of ICT, especially in relation to websites, blogs, and email as well as ICT-based media. Teachers also have not mastered the knowledge of ICT, learning strategies, and learning materials adjusted to the student’s character. Nevertheless, the teacher has been quite well mastered the knowledge of ICT to teach biology subject and knowledge about the proper ICT selection to support approaches, models, methods, and learning media.
3.2. TPACK Mastery of Biology Teachers Based on Gender

Mastery of teacher TPACK is examined based on teacher gender. TPACK data compared between male and female teachers with independent sample t test. The results of the teachers TPACK mastery analysis based on gender are presented in the following table.

| TPACK Domain | Male Mean | Male SD | Male Criteria | Female Mean | Female SD | Female Criteria | t     | P (two-tailed) |
|--------------|----------|--------|---------------|-------------|-----------|----------------|-------|---------------|
| PK           | 64.28    | 24.28  | Good          | 74.63       | 15.78     | Very good      | -1.334| 0.193         |
| CK           | 71.42    | 15.73  | Very good     | 73.04       | 10.63     | Very good      | -0.314| 0.756         |
| TK           | 46.42    | 22.49  | Fair          | 46.73       | 22.99     | Fair           | -0.031| 0.975         |
| PCK          | 45.23    | 18.5   | Fair          | 55.79       | 14.74     | Good           | -1.632| 0.114         |
| TCK          | 48.57    | 19.51  | Fair          | 56.52       | 17.73     | Good           | -1.016| 0.318         |
| TPK          | 68.57    | 25.44  | Very good     | 68.69       | 21.59     | Very good      | -0.013| 0.990         |
| TPACK        | 39.28    | 37.79  | Fair          | 47.82       | 22.50     | Fair           | -0.746| 0.462         |

Based on the results of the test, male teachers have a score of PK, CK, and TPK in very good category while the mastery of TK, PCK, TCK, and TPACK was still fair. The female teacher has a score of PK, CK, PCK, TCK, and TPK in good category but the TK and TPACK domains were still lacking. Furthermore, a different test was conducted which showed that there was no significant difference in the average TPACK between male and female teachers with a value of P > 0.05, meaning that mastery of teacher TPACK was not differentiated by teacher gender.

4. Discussion

Teacher's TPACK mastery was reviewed based on test. The result show that the average mastery of TPACK teachers was good with score of 59.15. Teacher has mastered the knowledge of pedagogic (PK), content (CK), pedagogical content (PCK) well. This results in accordance with the results of the UKG 2015, the biology teacher in the city of Yogyakarta were 63.17 in pedagogic, 74.22 in professional, and a total of 70.90. The professional score of teachers in UKG reflects the teacher's mastery of subject matter knowledge. Overall, the results of the UKG obtained has reached a minimum score limit of 55.00, meaning that the mastery of biological teachers in Yogyakarta has exceeded the minimum limit but the assessment based on UKG has not revealed teacher mastery about technology knowledge.

The results of this research showed that the teacher TK and TPACK domain was still fair. This result means that the teacher was still weak in the knowledge of technology and its integration in pedagogic and subject matter. This outcome in line with the research shows the biology teacher was still weak in the knowledge technology (TK) and best on pedagogical content knowledge (PCK) [29]. Nevertheless, the teacher has well mastered the knowledge of technology to present subject matter as well as technological knowledge to support the application of learning strategies. The lack of knowledge of ICT was the main cause teachers did not adopt the ICT in learning process [30]. Teachers who lack ICT knowledge tend to feel anxious if they have to use the ICT in class because the students were smarter in ICT [31]. Therefore, it is necessary to do a workshop to improve the knowledge of ICT teachers and how to apply it in the learning process.

TPACK mastery were measured based on mastering the knowledge. These results indicated that teacher TPACK wasn't influenced by gender. This results in accordance with some research that showed no significant gender influence on PK, CK, TK, PCK, TCK, TPK, and TPACK [8, 9, 10, 11]. The difference TPACK mastery may be due to a technological gap between male and female getting reduced. Imhof, Vollmeyer, & Beierlein reported that in the year 1990, males using ICT were more effective than female but these percentages decreased over time due to increased chances of accessing technology [32]. This condition indicates that the ease of internet access and the increasing number of
female of ICT Gap due to gender is decreasing therefore that the male and female levels in the use of ICT become equal. Gender influenced attitudes of ICT where the results of several studies had found that male had a more confident, positive attitude and relatively more experience with ICT [13, 14, 33, 34, 35] but were not affect the ability of ICT's mastery between male and female [14]. These results are backed research results showing no significant different between gender and ICT [36, 37]. The results of the study also showed no significant technological and pedagogical mastery differences between male and female teachers [38]. Therefore, teacher mastery of pedagogy, biology content, and technology between male and female teacher were same.

Other research showed obstacles in the integration of ICT in learning, namely the lack of teacher ICT ability, the lack of confidence in teachers being exposed to ICT, and lack of ICT training [39]. Lack of ICT knowledge was the main reason teachers lack confidence in adopting and integrating ICT in learning [31]. This is due to the fact that teachers who lack the knowledge of ICT would feel anxious if they have to use ICT in front of students who are smarter in using ICT [32, 40]. Teachers tend not to use technology in learning if they do not master technology knowledge.

5. Conclusion
TPACK mastery of biology teachers was good but still low in TK and TPACK domain. Teacher's TPACK mastery were not influenced by gender. The TPACK gap between male and female teachers does not seem even therefore the mastery of TK and TPACK between male and female teachers was equally fair. Therefore, the results of this research could provide recommendations for school principals and educational policy makers to provide teacher training to improve knowledge about technology and its integration to support pedagogic and content. In addition, it is hoped that teachers could apply their knowledge about TPACK in the learning process therefore that integrated ICT learning can be realized in accordance with the education in the 21st century.

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