The TPACK Analysis of High School Biology Teachers in Sragen Regency, Central Java Based on Teacher Certification Status

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Abstract. Technological Pedagogical and Content Knowledge (TPACK) is the combination of knowledge about PK, CK and TK. The purposes of this study were to find out how the TPACK of high school biology teachers in Sragen Regency and to find out whether there were differences in the TPACK between certified biology teachers and those who were not certified. The type of this research was descriptive research with survey methods. The population in this study was a hypothetical population (the forecast of the population, what the population is expected to be) and the sample representing the population was taken using convenience sampling techniques which included 17 biology teachers spread across 13 high schools in Sragen Regency. Based on the research that has been carried out, the results showed that the knowledge of PCK is very good (85.0%), TCK is poor (47.6%), TPK is fair (64.2%), and TPACK teachers were in a fairly poor category (51.3%). The results also showed that there was no significant difference between the TPACK of certified biology teachers and non-certified biology teachers with a significance value greater than 0.05.

1. Introduction

The 2005 Constitution No. 14 concerning teachers and lecturers stated that teachers are professional educators with the main task of teaching, guiding, directing, training, assessing and evaluating students, in early childhood education, formal education, basic education, and secondary education. The government has also formulated four types of teacher competencies in the perspective of national education policy as stated in the Explanation of Government Regulation No. 19 of 2005 concerning National Education Standards, namely pedagogical competencies, personality competencies, social competencies, and professional competencies. Competence is basically a description of what a person can do at work, and what forms of work can be shown. The teacher is required to be an agent of change (the agent of change), so that the teacher must be able to develop the teaching process in the class and continue to explore the ability to make a design or lesson plan, one of them is by understanding Pedagogical Content Knowledge (PCK). To teach biology is not enough to understand the content or teaching material (knowing science), but also have to think about how to teach well (how to teach)[1]. The main element that can be used as the basis of a teacher in carrying out the learning process is to master CK and PK, where the two components will become a unit called PCK[2].

Technological developments in the 21st century make teachers always have to develop their teaching abilities by not only mastering PCK, but teachers must be able to teach learning materials by
utilizing technology (ICT), which components will be integrated with each other and related to each other in Technological Pedagogical Content Knowledge (TPACK). Integrating technology with pedagogical knowledge and learning content has become important from educational programs\cite{3}. Integration of technological elements in the learning process in the 21st century is indeed necessary because learning activities require the application of technology both for teachers and students because the use of technology is expected to produce innovative learning processes.

The TPACK concept was taken from the description of PCK by Shulman, which was integrated to find out how the interaction between technology and PCK in producing an effective learning process. TPACK became a design that integrates technology in the learning process. TPACK is an intact combination of three basic knowledge, there are PK (Pedagogical Knowledge), CK (Content Knowledge), and TK (Technological Knowledge) that form the balance of PCK (Pedagogical Content Knowledge), TCK (Technological Content Knowledge), TPK (Technological Pedagogical Knowledge), and TPACK (Technological Pedagogical and Content Knowledge)\cite{4}. Mastery of TPACK is considered very important in answering the challenges of education in the 21st century because technology is basically helping teachers to continue to hone and develop their professionalism. For example, by using the internet, teachers can access various kinds of information about educational issues, teaching strategies, as well as being able to keep up with the progress of science that continues. TPACK can also help teachers build good competencies in schools because TPACK explains how to think new for teachers in dealing with problems in the class\cite{5}.

TPACK is indeed supposed to be understood by the teacher because in the standards of the Indonesian National Qualifications Framework, the teacher is at level 7. In this level, the teacher is required to be able to manage resources under their responsibility and evaluate comprehensively their work by utilizing science, technology, and art to produce strategic development steps for the organization. In improving the ability to use technology in the learning process, teachers must take part in teacher education programs. Although the teacher education program aimed to equip teachers in utilizing technology in learning, in reality, teacher training programs were still not able to improve the mastery of technology in learning\cite{6}.

Teacher's TPACK is influenced by many factors, both the factors within the teacher and external factors such as the carrying capacity of the teaching school to develop the teacher's TPACK. The factors that are thought to influence teacher’s TPACK include the status of teacher certification. Teacher certification is the provision of real recognition for a teacher who already has the competence to carry out educational services to certain educational units after passing the competency test held by the certification body\cite{7}. In the 2005 Constitution of the Republic of Indonesia, Number 14, Article 8 explains that certification teachers must have academic qualifications, competence, physical and spiritual health, and have the ability to realize national education goals.

Teacher certification programs can improve the quality of education, but the size of the effect of this increase differs for each school category \cite{8}. In Indonesia, teacher certification programs began in 2006. Furthermore, teachers can be assumed to be responsible for the success or failure of student performance, therefore the Indonesian government has sought to improve the qualifications and skills of Indonesian teachers through teacher certification programs \cite{9}. Teacher certification assumes that the work done by the teacher is professional work therefore that the teacher needs to be certified professionally according to the standards of professional work \cite{10}. Based on the statement, it can be concluded that the teacher with the title of certification must possess and master a number of competencies in terms of learning, one of which is to be able to understand TPACK.

Understanding of technology, material (content) and learning strategies is an important thing that must be mastered by teachers to become professional teachers. However, not only being a professional teacher, but the teacher must also be able to provide effective learning, with special abilities to integrate knowledge about technology, materials, learning processes, and students, including the biology teachers in State High School in Sragen Regency. The information on the government administration report at the end of the 2016 Fiscal Year of Sragen Regency explained that the percentage of Transition Numbers (AT) of students from junior high to senior high school has
increased from 87.4% to 94.22% (an increase of 6.74%). The increase in numbers was inseparable from the increasingly advanced human resources in Sragen Regency. This must be addressed by high school teachers to constantly develop the ability to teach in the classroom and sharpen their abilities in making learning designs, one of them is by understanding Technological Pedagogical Content Knowledge (TPACK). Based on the description related to the TPACK that teachers need to have in learning, then a study was conducted on the TPACK possessed by the teacher with the title “The TPACK Analysis of high school biology teachers in Sragen Regency, Central Java based on teacher certification status”.

2. Methods

2.1 Research Design

This type of research was a descriptive study with a survey method. This study aimed to find out how teacher’s TPACK in the learning process and to know the difference in teacher’s TPACK between certified biology teachers and non-certified biology teachers. The population in this study was a hypothetical population (the forecast of the population, what the population is expected to be), which included all biology teachers who taught at high schools in Sragen that once existed, which now exist, or which would exist. The sample that representing the population was taken using convenience sampling techniques or samples that are now available and easy to observe, in this case, the sample included 17 biology teachers spread from 13 high schools in Sragen Regency.

2.2 Research Instrument

The data in this study were the TPACK of the high school biology teachers. Data obtained through observation of learning activities carried out by the teacher by using instruments in the form of observation sheets. The data obtained then be collected and included in the observation sheet table which was then analyzed from the data that had been obtained. This method was chosen because it was more practical and simple. The instruments used were first tested for validity and reliability. After being declared valid and reliable, the instrument can be used to retrieve the TPACK of biology teachers.

2.3 Data Analysis

The data in this study were the TPACK of the high school biology teachers in Sragen Regency as seen from the learning process. The data was tabulated in the form of tables using instruments that had been made. The knowledge of TPACK was analyzed using descriptive analysis, while the influence of the variables on the teacher’s TPACK was analyzed using the independent sample t-test. To facilitate the grouping of teacher’s TPACK, several criteria were made. The criteria are: 84 % - 100 % (Very Good); 68 % - 83 % (Good); 52 % - 67 % (Fair); 36 % - 51 % (Poor); 0 % - 35 % (Bad)\[11\].

3. Results and Discussion

3.1. Result

3.1.1 Descriptive Analysis of teacher's TPACK

Descriptive analysis of TPACK can be seen in the following table:
Table 1. Descriptive Analysis of TPACK

| Aspect | Statistic | Score | Note   |
|--------|-----------|-------|--------|
| PCK    | Mean      | 85.0  |        |
|        | Maximum   | 94.4  | Very Good |
|        | Minimum   | 44.4  |        |
|        | Mean      | 47.6  |        |
| TCK    | Maximum   | 60.0  | Poor   |
|        | Minimum   | 40.0  |        |
|        | Mean      | 44.2  |        |
| TPK    | Maximum   | 72.7  | Fair   |
|        | Minimum   | 30.4  |        |
|        | Mean      | 51.3  |        |
| TPACK  | Maximum   | 57.1  | Fair   |
|        | Minimum   | 42.9  |        |

Table 1 explains how TPACK of high school biology teachers in Sragen Regency. The teacher’s TPACK is divided into four main components, namely PCK, TCK, TPK, and TPACK. Each component has a different level of knowledge. The results listed in Table 1 are results that are still comprehensive and not specific. It means that these results still cannot distinguish how the descriptions of teacher’s TPACK with different certification statuses. These results are still in the form of overall results from the sample used. In this case, the status of teacher certification is divided into two groups, namely certified teachers and non-certified teachers. To see the description of the biology teacher’s TPACK based on certification status can be seen in Table 2.

3.1.2 Description of the tendency of differences in the knowledge of TPACK

The tendency of differences TPACK of Biology Teacher can be seen in the following Table:

Table 2. The tendency of differences in Teacher’s TPACK

| Aspect | Teacher Certification Status |
|--------|-----------------------------|
|        | Certified | Not Certified |
| PCK    | 88.4      | 76.6        |
| TCK    | 48.3      | 46.0        |
| TPK    | 65.1      | 61.8        |
| TPACK  | 51.1      | 51.4        |
| Mean   | 63.23     | 58.95       |

Based on table 2, it can be seen that TPACK knowledge of certified teachers is better when compared to teachers who are not certified. But, actually these results haven’t been able to reveal significantly how different the knowledge of TPACK biology teachers. These results are still in the form of descriptive results that lead to the tendency of biology teachers to understand TPACK based on certification status.

To find out how the significance level of differences in knowledge of TPACK biology teachers, different tests were carried out using Independent Sample t-Test with results that can be seen in Table 3. The Independent Sample t-Test compares the means of two independent groups in order to determine whether there is statistical evidence that the associated population means are significantly different. The Independent Samples t-Test is a parametric test. With this analysis, the significance of differences in biology teacher tpack based on certification status will be known.
3.1.3 t-Test
The data was analyzed using the Independent Sample t-Test with the following results in table 3.

| Aspect | Certification | Sig  |
|--------|---------------|------|
| PCK    | Certified     | 0.224|
|        | Not Certified |      |
| TCK    | Certified     | 0.453|
|        | Not Certified |      |
| TPK    | Certified     | 0.599|
|        | Not Certified |      |
| TPACK  | Certified     | 0.951|
|        | Not Certified |      |

Table 3 explains that there is no difference in teacher’s PCK, TCK, TPK, and TPACK between certified teachers and non-certified teachers. This can be seen in the significance value or in the table stated in Asymp. Sig. (2-tailed) which has a value of more than 0.05, it can be said that there is no significant difference in teacher’s PCK, TCK, TPK, and TPACK between certified biology teachers and non-certified biology teachers.

3.2. Discussion
Based on the results obtained, it could be said that the biology teacher's PCK was very good (85%), TCK was poor (47.6%), TPK was fair (64.2%), and TPACK was in the fair category (51.3%). The knowledge of PCK in the learning process was in a very good category with a percentage of 85.0%. In this case, the teacher had been able to choose the right model, method, and learning media in accordance with the teaching material to be delivered to the students. The selection of learning models, methods and media were appropriate because when the learning process took place, students could follow the whole set of learning well. Active students asked questions and were also active in expressing opinions, and when the teacher gave questions, students were actively brave enough to answer these questions. When students expressed their opinions and also actively asked questions, the teacher swiftly made a small note to give an assessment to the student, both in the form of cognitive, affective, and psychomotor assessment.

The knowledge of TCK in the learning process fell into the poor category with a percentage of 47.6%. TCK is a unity of the two main elements that are important in learning, namely TK and CK. When observing, teachers were still limited in utilizing technology to be adapted to teaching material. In this case, the teachers had not been able to provide new information related to the material to the students, the teachers only used technology facilities (internet) to collect material to be delivered in the form of power points, where the material collected by the teacher was actually already in the student handbook. The importance of utilizing technology facilities to support the achievement of learning objectives was delivered by [12], the maximum use of technology will be able to make abstract material easier for students to learn. In this era of globalization, the use of technological resources as learning materials for students will make students have a high collaborative spirit, be flexible in exchanging information and knowledge, and constantly hone their abilities by continuing to learn.

TPK knowledge in the learning process was included in a fair category with a percentage of 64.2%. Knowledge about TPK refers to the suitability of technological elements for different learning activities [13]. In this case, the teacher’s TPK can be seen from how the teachers adjusted the use of technology (TK) with models, methods, and also learning media and the use of technology that was tailored to the characteristics of students (PK). From the observation results obtained by the fact that the teachers had not been fully able to use ICT-based learning media for the learning process, the
teachers were limited to the use of power points that contain many texts which were felt not enough to make students understand the material being taught. The knowledge of TPACK in the learning process was included in a fair / sufficient category with a percentage of 51.3%. The application of ICT (Information and Communication Technologies) in learning was still not maximal. Based on the results of interviews from several teachers, information was obtained that most of the teachers claimed that they did not really understand ICT because they did not use technology facilities too often in their daily lives. The use of technology facilities was limited to the use of the internet to gather information and use social media in the form of WhatsApp to communicate. The lack of maximum teachers in knowing TPACK in the learning process was also triggered by limited infrastructure facilities from the school. Some schools had wifi (hotspot area) facilities, but the area was only at one location point and the signal from the wifi did not reach the classroom. The problems in teacher performance were influenced by several factors, one of which was the low use of ICT due to the lack of teachers' ability to use it, and there was no obligation on the part of the school to use ICT during the learning process[14]. TPACK is a central element in achieving learning objectives because if TPACK is implemented correctly, students will get more meaningful learning. TPACK can be applied by collaborating three main elements, namely TK, PK, and CK. The importance of implementing TPACK is expressed by[15] which states that the implementation of TPACK strategies can improve mastery of concepts and learners' active learning. From the results of the study, it could be seen that the teacher's knowledge about TPACK had not fully fulfilled the main elements. But in this case, the teacher had been able to compile the material using modern learning media such as powerpoint, some of which already contained images, videos, and animations taken from the internet. Technology must be utilized properly to package a teaching material or certain material into a good media such as animation, simulation, and virtual lab so that students will be easier to understand the material[16].

From the results of the study also found that there were no significant differences regarding the knowledge of PCK, TCK, TPK, and TPACK in the learning process between the certified and non-certified teachers, with the results of the analysis in the form of significance values above 0.05. There was no significant difference because overall, the way to teach teachers in the classroom was not much different. The average teacher used discovery learning and problem-based learning models, and the methods used in teaching were lecture and discussion methods, the use of technological elements was limited to finding information related to learning material. Learning media was still limited to the use of laptops and the presentation of material in the form of power points which were dominated by the amount of text. Certified teachers had the understanding that the teacher had the competence to carry out educational services to certain educational units after passing the competency test held by the certification body[8]. But based on the results obtained, it was said that there was no significant difference between certified and non-certified teachers in knowing TPACK. To be able to master TPACK, of course, the teacher first mastered the PCK, TCK, and TPK. The absence of differences in the knowledge of TPACK is also due to the ability of teachers to master content, pedagogics, and technology is still not optimal. Even though, the NBC process (National Board Certification) or in this case the certification process affected five aspects of teaching practices related to PCK, including reflection on teaching practices, implementation of new teaching strategies and / or innovative, inquiry-oriented instruction, student learning assessment, and student understanding[17].

The absence of a significant difference in the TPACK between certified and non-certified teachers is clearly a problem. Teachers who get a certification degree should have good competence in the world of teaching. Whatever form of program to improve teacher quality and education, follow-up evaluations that maintain the sustainability of the program are very necessary. Status of certification for a teacher should not be permanent as in Indonesia, certification must have expired. When teacher certification has reached its final year, teachers need to be retested, and those who fail the certification test will not get the certification title. By applying this evaluation, certified teacher quality can be maintained[18]. Certified teachers are closely related to professional teachers, where teacher professionalism can be seen from a number of competencies they have. Teachers who have qualified
competencies are proven by obtaining a teacher certification degree[19]. Based on this explanation, as a teacher with a certification title, it should have a number of competencies in an adequate teaching field, one of which is being able to understand TPACK. Because, whether a teacher is good or not in providing learning to students will determine the achievement of learning goals.

Teachers must continue to learn to be able to design and develop technology to foster the success of students in this advanced and modern learning environment because applying technology will produce meaningful learning[20][22]. TPACK's poor knowledge illustrates that teachers still tend not to be able to properly implement technological, pedagogical and content elements. The teacher's lack of knowledge about TPACK is very unfortunate because TPACK is an important thing in addressing technological advances in the 21st century. Good knowledge about TPACK makes it easy for teachers to find solutions to deal with existing problems in class, TPACK can also be used to build teacher competency in schools[5].

Based on the results of the research obtained, it can be said that indeed the teacher certification status did not have a significant impact on the teacher's TPACK. As a teacher, both certified and non-certified teachers should have the skills to master everything related to their field of teaching. The teacher's profession is obtained by various conditions, one of which is the prospective teacher must take the level of teacher education which means that after graduating from teacher training, a teacher already has qualified capital to be applied in the world of teaching. Certification candidates must have completed a bachelor's degree, completed at least three full years of teaching or counseling before earning a degree, and have valid teaching or counseling licenses during that period[21].

4. Conclusion
Based on the research that had been carried out, the results showed that the teacher’s PCK was very good (85.0%), TCK was poor (47.6%), TPK was fair (64.2%), and TPACK teachers were in a fairly fair category (51.3%). The results also showed that there was no significant difference in TPACK between certified biology teachers and non-certified biology teachers with a significance value above 0.05.

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