Analysis Of Technological, Pedagogical, Content Knowledge (TPACK) Biology Teachers Ability In Medan City Toward Genetically Modified Organisms (GMO) Socioscintific Issues

Rotuanita Butarbutar [1], Ely Djulia[2], Ashar Hasairin[3], Wanri Lumbanraja[4]

{rotuanita@gmail.com[1], djulia247@gmail.com[2], asharhasairin@unimed.ac.id[3], lumbanrajawanri@gmail.com[4]}

Biology Educational Study Program of Postgraduate School of Universitas Negeri Medan, North Sumatera, Indonesia, 20221[1,2,3] Radiolody Department of STIKes Senior Medan, Jl. Djamin Ginting, KM 8,5 No. 13 Medan, North Sumatera, Indonesia[4]

Abstract. This study aims to analyze the ability of Technological Pedagogical Content Knowledge (TPACK) in high school biology teachers in Medan Toward Genetically Modified Organisms (GMO) Socioscintific Issues. The method used is descriptive research, where researchers do not provide treatment to the object of research. Researchers only retrieve data without any changes. The sampling technique used is total sampling by 43 teachers from 21 state senior high school (SMA) in Medan City. Data collected through the charging instrument TPACK. Analysis of data by encoding based on seven categories in the framework TPACK (CK, PK, TK, PCK, TPK, TCK, TPACK) by using descriptve qualitative techniques. In details, Pedagogical Knowledge (PK) average score was 57.6 (good enough). Content Knowledge (CK) was 53.49 (quite good). Technological Knowledge (TK) was 81.8 (very good). Pedagogical Content Knowledge (PCK) was 60.9 (quite good). Technological Content Knowledge (TCK) was 60 (fairly good). Pedagogical Knowledge (TPK) was 40 (bad). Technological Pedagogical Content Knowledge (TPACK) was 60.47 (quite good).

Keywords: Analysis, Cognitive Ability, TPACK

1 Introduction

In the 21st century, the latest science, technology, and art in the field of education are experiencing developments. 21st century teachers are required to have knowledge of technology and its use in learning and learning in addition to having knowledge of the material being taught and how to teach it. Technological knowledge in question is knowledge and skills in using various technological devices, both traditional and modern to facilitate learning and improve learning outcomes.

Material knowledge and pedagogic knowledge possessed by teachers must be balanced with technological knowledge. According to Prensky (2001) [1]., educators currently referred to as "Digital Immigrants" must be able to adjust planning and learning activities that are suitable for students who are referred to as "Digital Natives", themselves and learn with the latest aspects of digital technology. Meanwhile, Digital Natives are the generation who were born in the digital

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era and have been treated to technology from an early age. They live in an environment that is familiar with computers, the internet, cellular phones, and video games. on the digital technology.

Teachers or educators according to Law Number 20 of 2003 (Undang-Undang Nomor 20 Tahun 2003), National Education System Article 39, paragraph 2 (, Sistem Pendidikan Nasional Pasal 39, ayat 2) concerning Education Personnel states that "educators are professionals in charge of planning and implementing the learning process, assessing learning outcomes, conducting guidance and training and conducting research. and community service". Furthermore, Law Number 14 of 2005 (Undang-Undang Nomor 14 Tahun 2005) concerning Teachers and Lecturers states that teachers are professional educators with the main task of educating, teaching, guiding, directing, training, assessing and evaluating students in early childhood education through formal education, basic education and education. medium. From the two definitions above, it can be concluded that he role of teachers is very important to create a quality generation in the future.

Teachers have a role in planning and implementing the learning process, as well as conducting assessments, research, assessments and communication liaisons with the community [2]. One of the important factors for the success of a learning process can not be separated from the quality of the teacher. This is in line with the notes in the McKinsey report which states that "the quality of the education system is unlikely to exceed the quality of its teachers" [3]. So it is expected that today's teachers must have the ability in accordance with the times.

According to the Kemdikbudristek Team (2020) [4], there are various issues that contribute to the low learning outcomes of Indonesian students. First, the pedagogy and teaching effectiveness of Indonesian teachers still need to be improved. Teachers often act as knowledge transmitters, not learning facilitators. Many teachers allegedly do not focus on character development and arouse the desire to learn. In the case of the teacher asking questions, about 90% (ninety percent) of the student responses are only one-word answers. The teacher's way of asking questions is shallow, does not support the emergence of higher order thinking skills and the ability to explain logical thinking.

In this 21st century, science, technology, social context and the environment in which science technology operates must be able to be connected by science education itself. It is an important goal for teaching science, scientific literacy and technology of the entire population [5].

Material knowledge as a combination of pedagogic knowledge was developed by Shulman (1987) [6]. namely Pedagogical Content Knowledge (PCK). Teachers as educators are required to have pedagogical abilities, including curriculum development, syllabus and lesson planning. In Law Number 20 of 2003 (undang – undang nomor 20 Tahun 2003) concerning the National Education System, the function is to develop the capabilities and character and civilization of a dignified nation in the context of the intellectual life of the nation. For this reason, teachers must be able to develop ability and character-based learning tools to become a means of achieving national education goals. It can be concluded that teachers have a role in educating as learning resources, facilitators, managers, demonstrators, mentors and motivators [7].

The tough challenge faced by the world of education in Indonesia in a global complex is the ability of teachers to design teacher competency development plans called TPACK or Technological Pedagogical Content Knowledge. TPACK is a comprehensive integration of knowledge and skills in terms of material, and pedagogy that is integrated into technological developments. TPACK was first coined by Shulman (1987) [6]. and developed by Koehler & Mishra (2008) [8]. TPACK is considered as a potential framework that can provide new

directions for teachers in solving problems related to integrating ICT into teaching and learning activities in the classroom [9].

The purpose of this study was to analyze the TPACK abilities of state high school teachers throughout Medan.

2 Research Method

This research is a descriptive research with a quantitative approach. The sample is a total sample, namely biology teachers who teach at 21 public high schools throughout the city of Medan with a total sample of 43 teachers. The data obtained in the field through a knowledge test in the form of a google form which is processed using descriptive analysis.

Techniques and tools used to collect research data is the GMO material knowledge test sheet. The research data obtained will be analyzed with descriptive statistics.

To analyze the teacher's TPACK ability test data, it is done by looking for percentages and presented in descriptive form. For the correct answer was given a score of 1 and for the wrong answer was given a score of 0. Descriptive analysis using the formula according to Sugiyono (2011) [10]. as follows:

$$\text{Score} = \frac{\text{B}}{\text{N}} \text{ X } 100 \qquad (1)$$

Note:
B= Number of items answered correctly
N= Number of multiple choice items

The data obtained were then converted into qualitative criteria in Table 1.

Table 1. Classification of Qualitative Criteria

Range of Value	Qualitative Criteria
0 – 28	Not Very Good/ Very Bad
29 – 46	Not Good/ bad
47 – 64	Fairly Good
65 – 83	Well
84 – 100	Very good

3 Results And Discussion

The teacher's TPACK ability data was obtained by giving a test of 35 validated questions. The questions given are divided into seven TPACK aspects and the results are scored. Overall the average value of each aspect of TPACK can be seen in Figure 1.

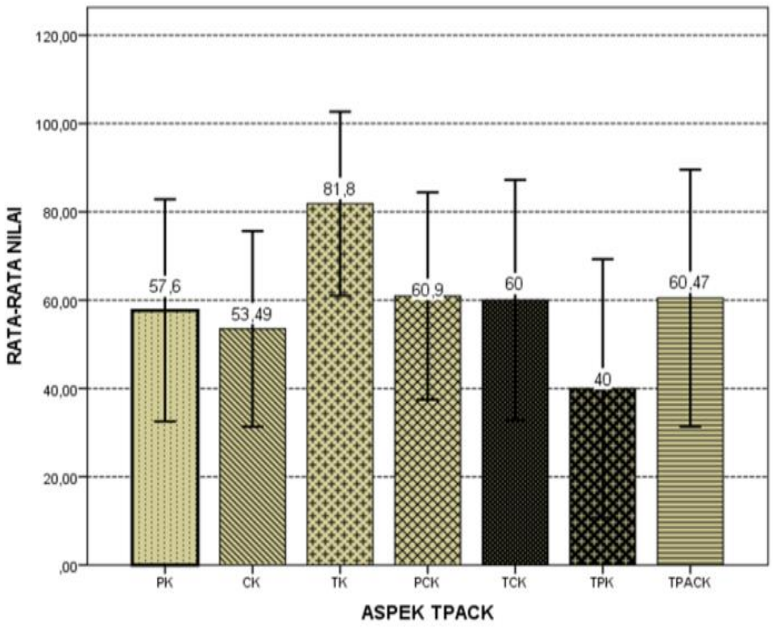

Figure 1. Results of the TPACK Ability of Biology Teachers at State Senior High Schools in Medan City.
Description: PK: Pedagogical Knowledge, TCK: Technological Content Knowledge, TK: Technological Knowledge, PCK: Pedagogical Content Knowledge, CK: Content Knowledge, TPK: Technological Pedagogical Knowledge, TPACK: Technological Pedagogical Content Knowledge

The results of the TPACK ability test for biology teachers throughout Medan City were on average 50.6 ± 14.65 ($\overline{X}$ ± SD). For each aspect of TPACK, data is obtained as shown in Figure 1 with the following details: Pedagogical Knowledge (PK) has an average of 57.6 ± 25.15 in a fairly good category. Content Knowledge (CK) has an average of 53.49 ± 22.13 quite good category. Technological Knowledge (TK) has an average of 81.8 ± 20.84 very good category. Pedagogical Content Knowledge (PCK) has an average of 60.9 ± 23.48 quite good category. Technological Content Knowledge (TCK) has an average of 60 ± 27.26 fairly good category. Technological Pedagogical Knowledge (TPK) has an average of 40 ± 29.27 bad categories. Technological Pedagogical Content Knowledge (TPACK) has an average of 60.47 ± 29.11 quite good category.

From Figure 1 it is clear that the standard deviation of each aspect of the teacher's TPACK ability is different. The lowest standard deviation value is in the Technological Knowledge (TK) aspect, which is 20.84. Meanwhile, the highest standard deviation value is found in the Technological Pedagogical Knowledge (TPK) aspect, which is 29.27. This shows the data obtained from the results of the teacher's TPACK ability with heterogeneous data distribution. Where the greater the value of the standard deviation of a data, the greater the distance between each data point and the average value.

Based on the test results, the average TPACK ability in the Technological Knowledge (TK) aspect has the highest score of 81.8 compared to other aspects. This shows that the ability of biology teachers who teach at SMA Negeri in Medan City in terms of mastery of technology in

learning is very good. While the average value of the TPACK ability test results in the Technological Pedagogical Knowledge (TPK) aspect has the lowest value compared to several other aspects, namely 40, this shows that biology teachers at SMA Negeri in Medan City on average are still not able to integrate technology with teacher pedagogic mastery.

3.1. Pedagogical Knowledge

Pedagogical knowledge is knowledge that includes how to manage classes, provide assessments, develop lesson plans and student learning processes[11]. Teachers must develop teaching skills such as being able to manage and organize classes, be able to achieve learning objectives well, knowledge to know how to organize conducive class activities.

Analysis of the ability of the pedagogical knowledge aspect of 43 school teachers has an average of 57.6 ± 25.15 quite good category. The results of the TPACK ability test on the Pedagogical Knowledge (PK) aspect can be seen in Figure 2.

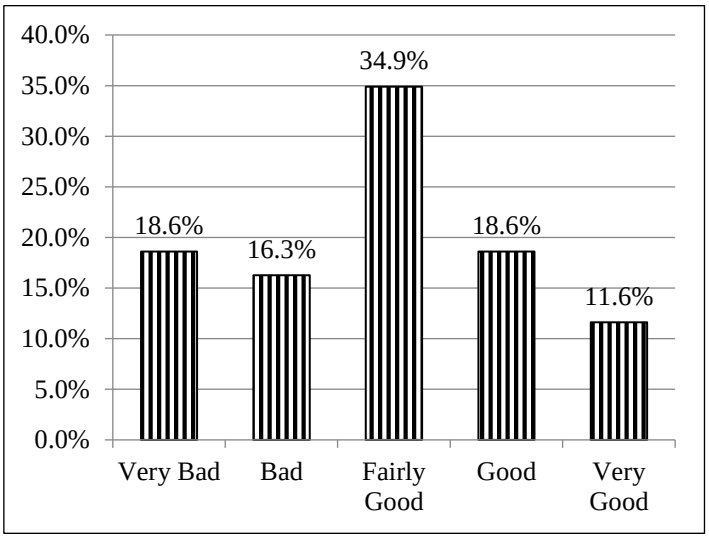

Figure 2 The results of the TPACK ability test on the Pedagogical Knowledge (PK) aspect .

Based on the data shown in Figure 2, there are 34.9% of respondents in the fairly good category. The percentage of good and very bad categories is in the same percentage, namely 18.6%, while the bad category is 16.3% and the very good category is 11.6% of the respondents. This explains that the pedagogic ability of biology teachers who teach in high schools throughout the city of Medan is quite good. The ability referred to in the aspect of ability to understand constructivism, behavioristic, cybernetic learning theories in learning in accordance with the circumstances of students. In addition, the ability to develop learning plans that support the achievement of the cognitive domain according to Bloom's taxonomy level. And quite good in compiling instruments for collecting and processing information on student learning outcomes correctly.

3.2. Content Knowledge

Content Knowledge is knowledge to develop that knowledge which includes concepts, theories, ideas, frameworks, knowledge of evidence, as well as practices and approaches. So the teacher must master teaching materials broadly and deeply about the material that is their field.
The data from the analysis of the ability of content knowledge for 43 school teachers has an average of 53.49 ± 22.13 in a fairly good category. The results of the TPACK ability test on the Content Knowledge (CK) aspect can be seen in Figure 3.

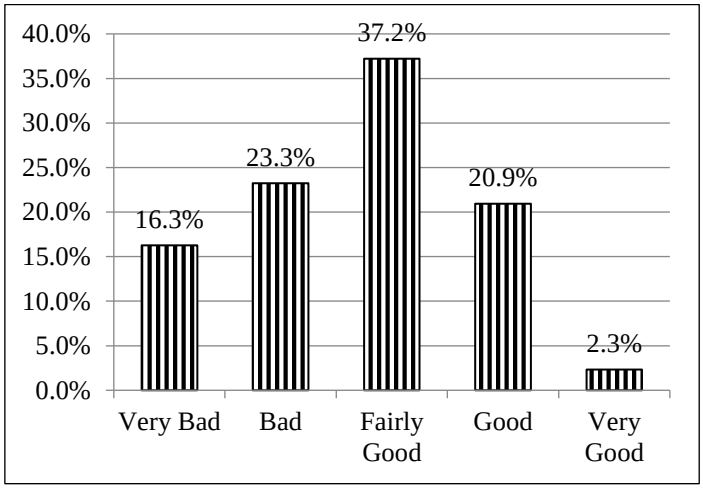

Figure 3 The results of the TPACK ability test on the Content Knowledge (CK) aspect.

Based on Figure 3, the ability of the content knowledge aspect of biology teachers in Medan City is 37.2% in the fairly good category, in the good category as much as 20.9%, and 2.3% in the very good category. However, there are 23.3% of the content knowledge abilities of biology teachers in Medan City which are in the bad category and 16.3% in the very poor category. genetic engineering, able to describe the process of genetic engineering on examples of genetically modified food in everyday life, and able to direct students to understand the advantages of transgenic plants as a food security solution

3.3. Technological Knowledge

Technological Knowledge (TK) is knowledge of how to operate computers and relevant software. Teachers and technology take an active role in shaping the learning environment. Teachers recognize that the existence of technology is very useful and needed. Teachers need good knowledge of certain technological abilities to assist students in learning certain topics or skills with the help of technology. From this point of view, technological knowledge not only refers to the instrumental skills needed to operate a technology but also implies knowledge of the ability of technology to achieve personal and professional goals [12].

The data from the analysis of the ability of content knowledge for 43 school teachers has an average of 53.49 ± 22.13 in a fairly good category. The results of the TPACK ability test on the Technological Knowledge (TK) aspect can be seen in Figure 4.

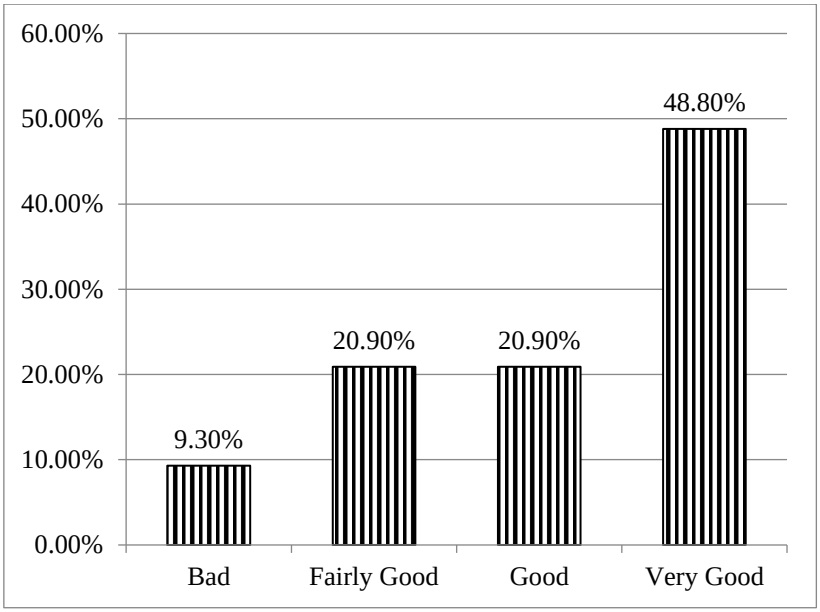

Figure 4 The results of the TPACK ability test on the Technological Knowledge (TK) aspect.

The results of the TPACK ability test on the Pedagogical Content Knowledge (PCK) aspect can be seen in Figure 4.4. The ability of Pedagogical Content Knowledge (pedagogical and content knowledge) of biology teachers in Medan City is 48.8%, including in the very good category, and the good and fairly good categories have the same percentage of 20.9%. And 9.3% is included in the bad category. The aspects in question include having knowledge of online learning support applications, understanding the use of appropriate online applications to measure students' cognitive abilities, and being able to understand the use of learning video applications that support learning.

3.4. Pedagogical Content Knowledge

There are five components of Pedagogical Content Knowledge: (1) science learning oriented, (2) knowledge and beliefs about curriculum science, (3) knowledge about students' understanding of science, (4) knowledge about scientific literacy assessment, and (5) knowledge about instructional strategy.
The data from the analysis of the ability of Pedagogical content knowledge on 43 school teachers has an average of 60.9 ± 23.48 fairly good categories. The results of the TPACK ability test on the Pedagogical Content Knowledge (PCK) aspect can be seen in Figure 5.

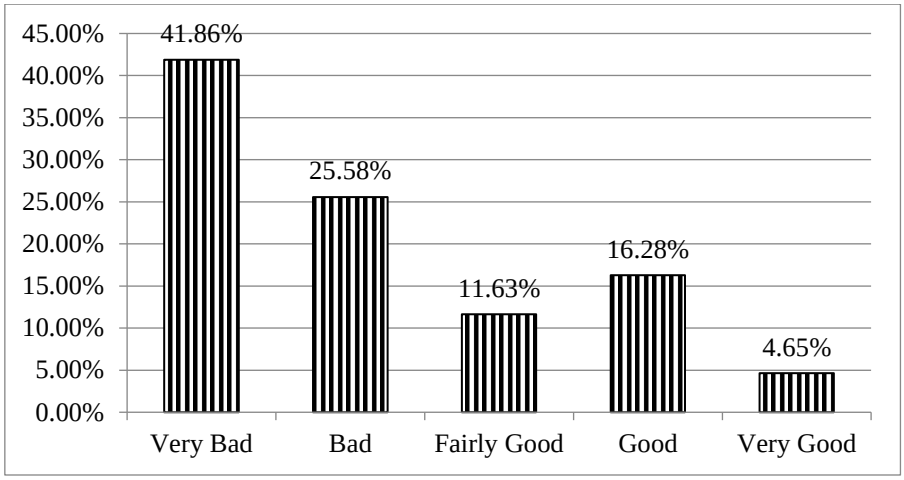

Figure 5 The results of the TPACK ability test on the Pedagogical Content Knowledge (PCK) aspect.

The results of the TPACK ability test on the Pedagogical Content Knowledge (PCK) aspect can be seen in Figure 4.6. Based on the picture, the TPACK ability in the Technological Content Knowledge (TCK) aspect of teachers is 11.63% in the very good category, namely 5 respondents from 43 people, 14 respondents or 32.56% in the good category, 8 respondents or 18.60% for quite good category, 10 respondents or 23.26% for the bad category, and 6 respondents or 13.95% for the very bad category.

The aspect in question is that the teacher is able to implement learning characteristics that make students active in biotechnology learning. The teacher is able to choose appropriate learning media to explain genetically engineered materials in plants and be able to make an instrument for assessing student learning outcomes that is in accordance with the material on GMO socio-scientific issues.

3.5. Technological Content Knowledge

Technological Content Knowledge is knowledge about the interrelationship between technology and content [13]. This knowledge invites teachers to understand that the use of certain technologies can change the way they understand concepts in certain content because Technological Content Knowledge is knowledge of how technology can create a new picture in certain materials.

The data from the analysis of the ability of Technological content knowledge on 43 school teachers have an average of 60 ± 27.26 in a fairly good category. The results of the TPACK ability test on the Technological Content Knowledge (TCK) aspect can be seen in Figure 6.

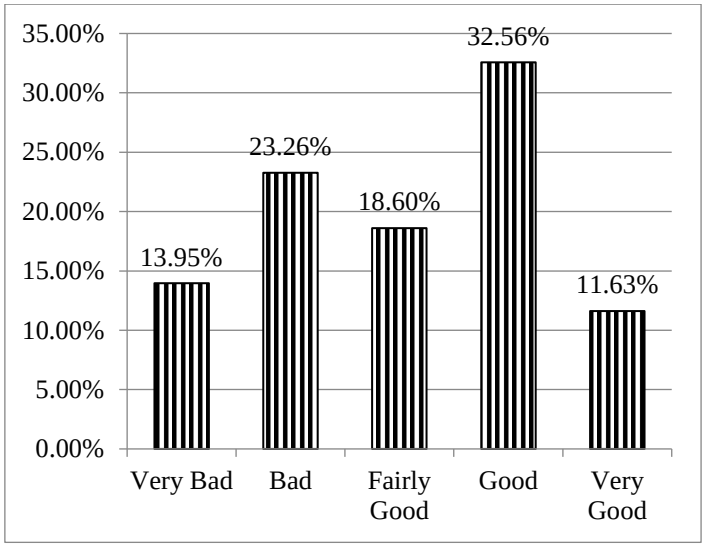

Figure 6 The results of the TPACK ability test on the Technological Content Knowledge (TCK) aspect

The results of the TPACK ability test on the Technological Content Knowledge (TCK) aspect can be seen in Figure 4.6. Based on the picture, the TPACK ability in the Technological Content Knowledge (TCK) aspect of teachers is 11.63% in the very good category, namely 5 respondents from 43 people, 14 respondents or 32.56% in the good category, 8 respondents or 18.60% for quite good category, 10 respondents or 23.26% for the bad category, and 6 respondents or 13.95% for the very bad category.

The aspect in question is that the teacher understands the use of appropriate media for genetic engineering process material. The teacher understands the use of applications for making student learning outcomes assessment instruments that are in accordance with the pandemic situation. The teacher understands the use of applications to make learning videos about genetic engineering and socio-scientific issues in society.

3.6. Technological Pedagogical Knowledge

Technological Pedagogical Knowledge is knowledge about how various technologies can be used in teaching and the use of these technologies can change the way teachers teach [11].

Analysis of the ability of aspects of Technological pedagogical knowledge on 43 school teachers has an average of 40 ± 29.27 not good category. The results of the TPACK ability test on the Technological Pedagogical Knowledge (TPK) aspect can be seen in Figure 7.

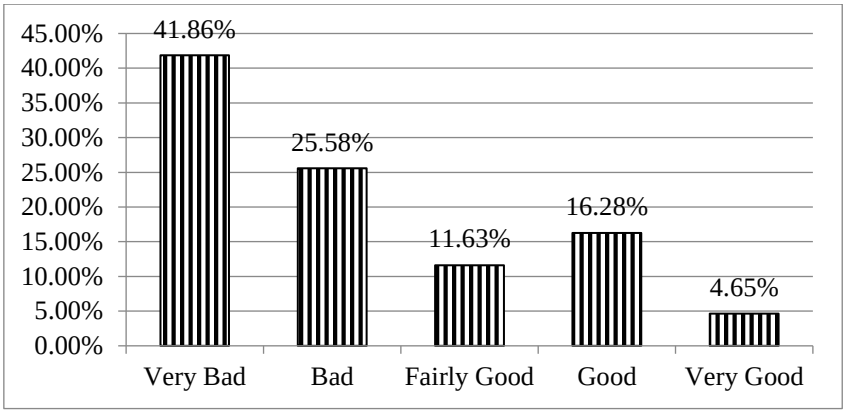

Figure 7 The results of the TPACK ability test on the Technological Pedagogical Knowledge (TPK) aspect.

The results of the TPACK ability test on the Technological Pedagogical Knowledge (TPK) aspect can be seen in Figure 4.7. Based on the picture there are 2 respondents from 43 people or 4.65% in the very good category, 7 respondents or 16.28% in the good category, 5 respondents or 11.63% in the fairly good category, 11 respondents or 25.58% in the good category. not good category, and 18 respondents or 41, 86% in very bad category. In the sense that teachers are still not able to adapt ICT to the learning model used to create interactive learning. Teachers are less able to choose the appropriate technology for learning media.

3.7. Technological Pedagogical Content Knowledge

TPACK is the knowledge needed by teachers to integrate technology in the learning process so that it becomes a complete package. Teachers must have an intuitive understanding of the complex interactions between the three basic components of knowledge, namely PK, CK and TK, by teaching certain materials using appropriate pedagogic methods and technology [11].
The data from the analysis of the ability of Technological Pedagogical content knowledge on 43 school teachers has an average of 60.47 ± 29.11 quite good categories. The results of the TPACK ability test on the Technological Pedagogical Content Knowledge (TPACK) aspect can be seen in Figure 8.

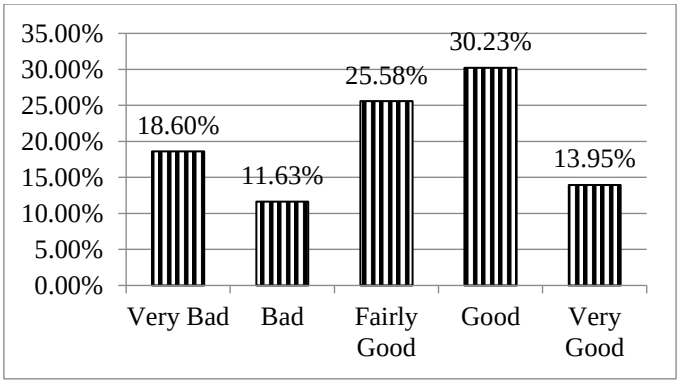

Figure 8 The results of the TPACK ability test on the Technological Pedagogical Content Knowledge (TPACK) aspect.

The results of the TPACK ability test on the Technological Pedagogical Content Knowledge (TPACK) aspect can be seen in Figure 4.8. In the picture, it can be seen that the TPACK ability in the Technological Pedagogical Content Knowledge aspect of biology teachers at SMA Negeri in Medan is spread in 5 categories, namely the very good category, there are 13.95%, namely 6 people from 43 respondents, in the good category there are 13 respondents, namely 30, 23%, the category is quite good, there are 25.58%, namely 11 respondents, the category is not good, there are 5 respondents, namely 11.63%, and the category is very bad, there are 8 respondents, namely 18.60%. In this case, the aspect in question is that the teacher is able to choose the right learning media for the material on the positive and negative impacts (socio-scientific issues) of genetic engineering. Teachers are able to use learning video maker applications to describe the genetic engineering process on examples of genetically modified food in everyday life. Teachers are able to bridge between science researchers and students related to the development of biotechnology by using trusted sources. Teachers are able to provide students with an understanding of the impact of biotechnology developments in the food sector by providing supportive and interesting sources.

4 Conclusion

The research result shows that in details, Pedagogical Knowledge (PK) average score was 57.6 (good enough). Content Knowledge (CK) was 53.49 (quite good). Technological Knowledge (TK) was 81.8 (very good). Pedagogical Content Knowledge (PCK) was 60.9 (quite good). Technological Content Knowledge (TCK) was 60 (fairly good). Pedagogical Knowledge (TPK) was 40 (bad). Technological Pedagogical Content Knowledge (TPACK) was 60.47 (quite good).

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