Analysis Of The Ability Of Technolgical, Pedagogical, Content, Knowledge Of Senior High School Teachers In Developing Learning Tools

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Abstract. This study aims to investigate Teachers' Level of Preparation towards the Integration of Technology, Pedagogy and Content (TPAC) in an educational context. The main focus of this research is to understand the extent to which teachers have the knowledge and skills in integrating technology in the learning process with attention to pedagogy and content elements. The research method used involved a survey and quantitative and qualitative data analysis to assess teachers' TPAC. Surveys were conducted to collect demographic data and teachers' level of understanding of TPAC aspects, the samples used were 3 biology teachers in SMA Negeri 1 Kupang The results showed that the teacher's TPACK ability was quite good with a technological knowledge (TK) score of 43.6%, pedagogical knowledge (PK) of 52%, content knowledge (CK) of 75.6%, technological content knowledge (TCK) of 53.3%, pedagogical content knowledge (PCK) of 51.3%, technological pedagogical knowledge (TPK) of 61.6% and TPACK of 49.6%.

Keywords: learning tools, technological**,** pedagogical, and content, knowledge

1. Introduction

TPACK (Technological Pedagogical Content Knowledge) in learning marks a paradigm shift in education. This framework recognizes that successful learning depends not only on understanding the subject matter (content), but also on teachers' teaching skills (pedagogical) and wise integration of technology.

The importance of TPACK lies in the integration of all three. An effective approach involves not only using technology, but also considering how best to teach the material and how the content can be adapted to the technology used. Teachers with good TPACK can create a dynamic and relevant learning environment, stimulating student creativity and facilitating deep understanding (Alhababi, 2017; Nurpratiwi et al., 2021). In an era where technology is increasingly changing the way we learn and teach, the TPACK approach is becoming increasingly relevant.

Through the incorporation of pedagogical, content and technological knowledge, TPACK creates a foundation for richer and more meaningful learning experiences (Chen et al., 2022; T. S. Koehler et al., 2014). Teachers who understand and apply TPACK can make a major contribution towards developing students' skills and knowledge to face an increasingly connected and computing future. Along with the challenges, the effort to integrate TPACK in learning is a worthwhile investment to advance education to new heights (Iskandar, 2022; James & Cobanoglu, 2017; Kimmons, 2018.; Knolton, 2014).

TPACK emphasizes on the seamless integration of PK, CK and TK. This is not about adding one type of knowledge to another, but rather creating a space where the three elements synergize to create a better learning experience. This integration requires reflection and creativity from teachers to design meaningful learning.

TPACK helps students develop skills needed in the digital age, such as critical thinking, collaboration, and media literacy. Teachers who use TPACK can provide teaching that is more effective and relevant to students' needs and implementing TPACK often requires changes in school culture and curriculum adjustments, which are not always easy to do (Becker, 2021; Beri, 2021; Gee & Wang, 2020).

The utilization of TPACK in learning offers a holistic and effective approach to curriculum development and teaching. By integrating pedagogical, content and technological knowledge, teachers can create more relevant, engaging and meaningful learning experiences for students. While there are some challenges that need to be overcome, the benefits offered by TPACK utilization far outweigh the effort required to implement it. With the right commitment and support, TPACK utilization can be a strong foundation for improving the quality of learning in various educational contexts.

The integration of TPACK was able to increase self-confidence and increase teachers' content, pedagogical, and technological competencies in designing learning (Ilahude et al., 2023). Therefore, the pattern of developing teacher competence with TPACK is a suitable way to ensure the implementation of learning in accordance with the demands and changes that occur. Before teacher competency development is carried out, the condition of teachers' TPACK ability must be analyzed, which will become the basis for policy formulation. TPACK is considered as a framework that can provide a new direction for teachers to solve the problem of how to integrate ICT into classroom learning.

2. Literature Review

Learning Tools

Learning tools refer to any form of tools, technology or media used to support the learning process. In this modern era, learning tools have undergone rapid development, creating various opportunities and challenges in education. Learning tools have become a crucial element in improving the effectiveness and efficiency of learning (Puspitarini & Hanif, 2019). Along with the advancement of technology, learning approaches that use these tools are increasingly popular at various levels of education. These tools cover a wide range of technologies, from hardware to software specifically designed to support the teaching-learning process.

As information technology develops, learning tools have undergone a significant transformation (Okoye et al., 2023). Initially, learning tools may have been limited to whiteboards and printed books. However, with the advent of computers, the internet and smart devices, the approach to learning has changed drastically. Hardware such as projectors, laptops and tablets are becoming common in classrooms, while educational software is becoming more diverse and innovative (Nurdin et al., 2021).

There are several types of learning tools, namely (1) Interactive Whiteboard (PTI). PTI is a development of a regular whiteboard that allows teachers and students to interact directly with digital displays (Herawati & Sundari, 2023). This allows teachers to present learning materials more dynamically and interactively; (2) Computers and Laptops. Computers and laptops are becoming key devices in modern education. They provide access to various information sources, educational software, and facilitate online learning; (3) Tablets and Smartphones. Mobile devices such as tablets and smartphones allow quick access to educational apps, digital books, and various interactive learning resources; (4) Learning Apps. A variety of specialized apps have been developed to assist learning in various subjects. From math to foreign languages, these apps help students learn in a fun and engaging way; (5) Educative Simulations and Games. Simulations and educational games provide practical and fun learning experiences. They help students understand abstract concepts through interaction and hands-on experience (Galarneau, 2005).

In addition, learning tools are very useful in implementing learning. The benefits of learning tools are, (1) Interactive and Interesting. The use of learning tools creates a more interactive and engaging learning experience. This helps increase student engagement and facilitates better understanding of concepts; (2) Quick access to information. With devices such as computers and the internet, students can access information quickly and easily. This opens the door for independent learning and further research (Quigley, 2011); (3) Personalization of Learning. Learning devices allow personalization of learning according to individual needs. Teachers can use various software to present materials with approaches that suit each student's learning style; (4) Distance learning. Learning tools have enabled the development of distance learning. Especially during the global pandemic situation, this technology becomes crucial to ensure the continuity of education.

However, along with its benefits, the use of learning tools also poses a number of challenges. Some of these include inequality of access, concerns regarding digital security, and the social impact of increased use of technology in everyday life (Sophie & Samantha, 2020). The use of learning tools also creates changes in the role of teachers. Teachers are not only information deliverers, but also learning facilitators who support students in developing critical skills, problem solving and creativity.

Technological

Learning technology is a concept that includes the utilization of technology to improve the learning process. Along with the rapid development of information and communication technology, education is undergoing a significant transformation. Learning technology, or e-learning, refers to the use of technology to support and enhance learning (Ali & Maksum, 2020). It involves the utilization of hardware, software and communication networks to convey information and facilitate interaction between learners and learning materials. Learning technology includes not only online learning approaches, but also various tools and applications used in traditional learning (Ghavifekr et al., 2015). There are several types of learning technology, namely (Learning Management System (LMS). LMS is an online platform used to manage and deliver learning content. Teachers can create materials, assign tasks, and track students' progress through this system; (2) E-books and Digital Materials. The use of digital books and e-learning materials allows easy access to information and further interactivity, such as videos, simulations, and hyperlinks to additional resources (Haleem et al., 2022); (3) Learning Videos. Learning videos allow students to learn through visualization of complex concepts. Videos can be presented in the form of online lectures, tutorials, or practical demonstrations; Webinars and online lectures. Technology makes it possible to organize lectures and seminars online. This allows participation from a distance and provides greater accessibility to students who cannot be physically present; (4) Learning apps. There are various apps specifically designed to support learning. These include apps for math, language, science, and various other disciplines that provide interactive exercises.

In addition, technology is very useful in learning. These benefits include: (1) Global Accessibility. Learning technology enables global access to education. Students from different locations can take online courses without geographical restrictions; (2) Self-directed learning. Students can learn independently by using learning technology. They can access materials, complete assignments, and measure their own progress with the help of learning software; (3) Intersactivity and engagement. Technology brings an element of interactivity to learning. Through online forums, educational games, and collaborative tools, students can be more actively involved in the learning process (Zuhir et al., 2021); (4)

Personalization of learning. With technology, learning can be personalized according to individual needs and learning styles. Intelligent algorithms can customize learning content based on student performance; (5) Measurable progress. LMS and analytics tools allow teachers and administrators to track student progress more effectively. This provides valuable information to assess the effectiveness of the curriculum and identify areas that require additional attention.

The utilization of learning technology certainly has challenges in its application in the field. These challenges include, (1) Inequality of access. Although learning technology provides global access, there are still challenges of inequality of access (Tadesse & Muluye, 2020). Some areas may not have adequate infrastructure or resources to support online learning; (2) Difficulty of use. Not all teachers and students are comfortable using technology. Usage challenges and sufficient training to adopt these technologies can be barriers; (3) Security Issues. Data security and privacy are serious issues in online learning. In a digital environment, it is important to protect students' personal information and counter potential risks; (4) Dependence on Internet connection. Dependence on Internet connection can be an obstacle, especially in areas that are not yet fully connected. This can limit student and teacher access to online learning resources; (5) Lack of social interaction. Although technology provides various tools for collaboration, some people expressed concerns about the lack of social interaction in online learning (Costa, 2015). This can affect the social and emotional aspects of learning.

Recent Trends in Learning Technology include (1) Artificial Intelligence (AI) and Machine Learning. AI and machine learning are used to develop learning solutions that can adapt to individual needs, analyze learning patterns, and provide more precise recommendations (Igbokwe, 2023); (2) Virtual Reality (VR) and Augmented Reality (AR). VR and AR provide immersive and realistic learning experiences. They can be used in simulations, experiments, and virtual tours to enhance the understanding of certain concepts (Al-ansi et al., 2023); (3) Adaptive learning. Adaptive learning systems use data and analytics to customize learning content based on individual abilities and needs; and (4) Block chain in education. The use of block chain technology can improve data security, reduce falsification of educational credentials, and simplify the process of managing academic records.

Learning technology has brought profound changes in education, opening new opportunities for education that is more inclusive, interactive, and relevant to the demands of the times, with the hope that it can continue to be developed wisely to provide maximum benefits for the world of education.

Pedagogy

Pedagogy is a branch of education concerned with the theory and practice of teaching. It involves a deep understanding of how humans learn, effective teaching methods and strategies to improve the learning process. In the context of learning, pedagogy plays a crucial role in developing teaching strategies that are motivating, effective and appropriate to the needs of learners. Key concepts in pedagogy, their role in learning, and how they can be applied can help create an optimal learning environment.

Key Concepts in Pedagogy (1) Learner Personality Pedagogy pays attention to individual differences in how students learn. This concept includes learning styles, intelligence, and the uniqueness of each learner. Teachers who understand learner personality can customize teaching methods to support this diversity (Barthelmeh & Carey, 2016). (2) Motivation. Pedagogy examines the motivational factors that influence the learning process. Understanding what motivates students helps teachers design engaging and relevant learning experiences. (3) Learning processes. Pedagogy understands how humans process information, store knowledge and develop understanding. This involves applying teaching methods that support students' cognitive processes. (4) Evaluation of Learning. Assessing student progress is an important part of the science of pedagogy. This involves developing fair and relevant evaluation methods to measure students' understanding and abilities. (5) Classroom Management. The science of pedagogy addresses effective strategies for managing the classroom, including the application of positive discipline, the establishment of a safe learning climate, and building positive relationships between teachers and students (Tufail et al., 2023).

Pedagogy has an important role in learning. Teachers as executors of learning need to do several things, including: (1) Designing a Relevant Curriculum: By understanding the needs and level of understanding of students, pedagogy helps in designing a relevant curriculum. This ensures that the learning materials match the developmental level and needs of the students; (2) Identifying Learning Styles. Teachers who apply the science of pedagogy can identify students' learning styles. This allows customization of teaching methods, such as the use of visual, additive, or kinesthetic, to enhance understanding; (3) Increase motivation. Pedagogy helps teachers understand students' motivational factors. By motivating students, teachers can create an environment that stimulates the desire to learn and achieve better; (4) Application of Active Learning Methods. Pedagogy encourages the application of active learning methods. Teachers can use discussion approaches, collaborative projects, or problem-based learning to increase student participation and understanding of the material (Ariyanto & Muslim, 2019); (5) Developing critical thinking skills. Teachers who understand pedagogy can develop students' critical thinking skills. This includes stimulating questions, encouraging discussion, and presenting learning materials that require analytical thinking; and (6) providing constructive feedback. The science of pedagogy helps in providing constructive feedback. Teachers can design assessments and provide feedback that supports student development without punishing or making students feel unmotivated.

Application of Pedagogy in the Modern Context by implementing online learning. Pedagogy becomes important in the context of online learning. Teachers need to understand how to create interaction, motivate students, and deliver materials effectively through digital platforms. Besides online learning, teachers can implement project-based learning (Ginusti, 2023). The science of pedagogy supports the project-based learning approach. Teachers can design projects that replicate real-world challenges, enhancing problem-solving and cooperation skills. Teachers can also conduct

collaborative learning and utilize technology (Alexander, 2023). In the context of collaborative learning, pedagogy helps teachers facilitate cooperation between students. It creates an environment where students learn from each other and develop social skills. Pedagogy guides the use of educational technology, including educational apps, learning software and online platforms. Technology integration can increase interactivity and student engagement.
Challenges and Innovations the application of pedagogy in teaching challenges teachers to innovate. The main challenge is to address inequalities in learning. Pedagogy continues to innovate to create methods that support student diversity. In the digital age, teachers need to understand how to use technology wisely. Pedagogy helps design strategies that minimize the negative impacts and maximize the benefits of technology in learning. Another challenge is to increase student engagement. Pedagogy is constantly looking for innovations to make learning more interesting and relevant for an increasingly connected generation.

Content

The content of learning materials is a key element in designing effective learning experiences. It includes the information, concepts and skills to be conveyed to learners. Learning content is the foundation of students' understanding of a concept or topic. Developing clear and relevant content is essential to ensure students can understand the information well (Darling-hammond et al., 2020). Interesting and relevant content can increase students' motivation and engagement in the learning process. When students feel that learning materials are relevant to their daily lives or have practical applications, they are more likely to be actively engaged (Ginting, 2021). Well-designed material content provides a foundation for independent learning. Students can use the content as a reference source to understand difficult concepts or pursue a deeper understanding.
Learning content helps teacher's present information in a clear and structured manner. By designing content that is logical and easy to understand, students can more effectively master the learning material. Before developing content, teachers must set clear learning objectives. These objectives will serve as a guide in determining what information and skills need to be conveyed to students (Kim & Seidman, 2019). Each student has a different learning style. Therefore, the learning content needs to be adapted to meet the needs of diverse students, including visual, auditory and kinesthetic (Noviska et al.,2023). Learning content can be more effectively delivered through active learning methods. These include group discussions, problem-based projects, simulations, or experiments that involve students directly. Technology can be a very effective tool in developing and presenting learning content. The use of multimedia, educational apps and online platforms can increase the interactivity and appeal of the material. Learning content accompanied by case studies and real-life examples can help students see the practical application of the concepts learned (Mahdi et al., 2020). This makes learning more meaningful and relevant. Learning material content can be enriched by including various sources of information. Textbooks, articles, videos and online resources can be used to provide diverse perspectives and support student understanding (Shabiralyani et al., 2015).
Structured and relevant learning material content can help students achieve a deeper understanding of the topics studied. They can relate the concepts to prior knowledge and build a solid foundation. Through the content of the learning materials, students can develop certain skills. For example, through problem-based projects or practical assignments, students can learn to apply the concepts they learn in real-life situations. Interesting and relevant content can increase students' motivation to learn (Shin, 2018). They are more likely to actively engage in learning, ask questions and seek deeper understanding. Content that provides a thorough understanding of concepts also promotes lifelong learning. Students who understand the material well are more likely to continue their exploration and learning beyond the classroom.
A key challenge is the inequality of student access to learning resources. Developing content that is accessible to all students, including those with limited access, is crucial. Creating quality material content takes time and effort. Teachers must manage their time wisely to ensure that the content delivered meets students' learning needs. Each student has different needs and levels of understanding. The challenge in developing content is to make it accessible and useful for all students, without leaving out students who may require a more individualized approach (Barrot et al., 2021).
The content of learning materials is an important foundation in creating effective and meaningful learning experiences. By designing clear, relevant and engaging content, teachers can improve student understanding, motivation and engagement. While challenges such as inequality of access and time management remain, innovations in content development can help create an inclusive and empowering learning environment for all learners.

Knowledge

Knowledge plays a central role in learning. It encompasses the understanding, information and skills that students gain from their learning experiences. Knowledge is the main foundation for understanding. Students need to have basic knowledge of a topic before they can understand more complex concepts (Feltovich et al., 2021). For example, understanding history requires basic knowledge of key events. Knowledge forms the basis for skill development. For example, in math, knowledge of basic concepts such as addition and subtraction is a prerequisite for developing more complex calculation skills. Knowledge provides tools for students to solve problems. By having a strong knowledge of a topic, students can apply that knowledge to design effective solutions to the problem at hand (Dunlosky et al., 2013). Knowledge of the relevance of a topic can motivate students to learn. When students realize the usefulness and relevance of knowledge in their daily lives or future careers, they are more likely to be motivated to pursue deeper

understanding. Knowledge helps students in informational decision-making. By having sufficient knowledge about a topic, students can make better and more informed decisions in various situations.

Active learning methods, such as group discussions, experiments, and problem-based projects, can help students construct knowledge actively (Munna & Kalam, 2021). Through direct participation, students can design a deeper understanding. Educational technology can be an effective tool in knowledge development. Educational apps, online resources and multimedia can present information in an engaging and interactive way. Class discussions and group work give students the opportunity to share and build knowledge together. Students can teach and learn from each other, explore different viewpoints and gain a more comprehensive understanding. Knowledge development can be strengthened by applying a contextual approach. Relating knowledge to real situations or contexts makes it easier to remember and apply. More than just remembering facts, knowledge development in learning includes deep understanding (Hailikari, 2022). Teachers need to emphasize on key concepts and relationships between information to create a solid understanding. Providing diverse sources of information helps students build comprehensive knowledge. This can involve textbooks, articles, videos, presentations and practical experience.

Knowledge plays a crucial role in improving students' critical thinking skills. When students are accustomed to analysing information, asking critical questions, and linking knowledge from multiple sources, they develop strong critical thinking skills. Good knowledge provides a solid foundation for the development of speaking and writing skills. By having a wide range of knowledge, students can structure arguments, detail information clearly, and communicate ideas effectively (Joynes & Rossignoli, 2019). Knowledge helps shape students' identity and their values. With the exploration of knowledge on various topics, students can form their own worldview and strengthen their values. Students who have strong knowledge are more likely to be independent learners. They have the tools to explore topics in greater depth, seek answers to their own questions, and engage in lifelong learning. Knowledge provides the foundation for the development of problem-solving skills. Students who are familiar with a wide range of concepts and information are better able to identify problems, analyze options and formulate effective solutions (Alsaleh, 2020).

A major challenge is information overload. With so many sources of information available, students and teachers must be able to select relevant information and manage the amount of incoming information to avoid information overload (Arnold et al., 2023). Inequality of student access to learning resources can be a challenge. Some students may not have equal access to reading materials, online resources or learning opportunities. Another challenge is the lack of student engagement in acquiring knowledge. Factors such as lack of motivation, uninteresting curriculum, or inappropriate teaching methods can hinder knowledge development (Mauliya et al., 2020).

Knowledge plays a crucial role in the learning process. It is not just about remembering facts, but also about understanding concepts, developing critical thinking skills, and forming a foundation for the development of other skills. By using effective development strategies, teachers can help students build knowledge that is solid and relevant to their future needs. While there are challenges such as information overload and inequality of access, continuous efforts in improving the learning process can help create an environment where knowledge can develop optimally.

3. Method and Materials

This type of research is descriptive with a quantitative approach, with sampling using cluster sampling technique. The number of respondents was determined by random sampling technique, namely 1 teacher who taught in class X, 1 teacher who taught in class XI, and 1 teacher in class XII. Data obtained in the field through observation were processed using quantitative analysis. Furthermore, the data was analyzed using the Miles and Huberman method, namely data reduction. The techniques and tools used to collect research data are learning observation sheets that have been declared valid in previous studies. The research data obtained will be analyzed with descriptive statistics and document analysis. Data analysis procedures resulting from research instruments that use a Likert Scale in accordance with table 1.

Table 1. Kategori Skala Likert

Interval	Criteria
3.25 < score ≤ 4.00	Very Good (SB)
2.50 < score ≤ 3.25	Good (B)
1.75 < score ≤ 2.50	Less (K)
1,00 < score ≤ 1,75	Very Less)

The formula used to convert the scores obtained into percentage form is as follows.

$$\text{Rate} = \frac{\textit{score obtained}}{\textit{maximum score}} \times 100\%$$

Table 2 Percentage Ranges and Qualitative Criteria

Nilai	Rentang	Kriteria
1	0-20	Very Less
2	21-40	Less
3	41-60	Fair
4	61-80	Good
5	81-100	Very Good

4. Result

TPACK analysis is divided into several aspects, namely,, Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK),Technological Pedagogical Knowledge (TPK),Pedagogical Content Knowledge (PCK) andTechnological Content Knowledge (TCK).

Content Knowledge (CK)

The data from the analysis of content knowledge abilities in three teachers obtained an average result of 75.6% in the good category. Table 3 shows that G1 has a score of 75% in the good category, G2 has a score of 81% in the good category, and G3 has a score of 71% in the good category. These results show that the respondents have the ability to master good material and teach it to students well..

Table 3. Analysis of CK aspect ability

No	Teacher Code	CK Score (%)	Criterion qualitative
1	G1	75	Good
2	G2	81	Good
3	G3	71	Good
Average		75,6	Good

Pedagogical Knowledge (PK)

Analysis of the ability of pedagogical knowledge aspects in three teachers has an average of 52% in the sufficient category. In table 4, it can be seen that G1 has a score of 51% in the sufficient category, G2 has a score of 44% in the sufficient category, and G3 has a score of 61 in the sufficient category. These results indicate that the ability to master learning pedagogy is sufficient.

Table 4. PK Aspect Capability Analysis

No	Teacher Code	PK Score (%)	Criterion qualitative
1	G1	51	Sufficient
2	G2	44	Sufficient
3	G3	61	Sufficient
Average		52	Sufficient

Tecknological Knowledge (TK)

Analysis of technological knowledge abilities in 3 teachers in managing learning tools has an average score of 43.6% in the sufficient category. Table 5 shows the value of respondent G1 is 47% in the moderate category, G2 is 41% in the insufficient category, and G3 is 43 in the insufficient category. The ability to master technological knowledge of the three respondents has an average of sufficient, but respondents G2 and G3 have less knowledge, so they must increase their knowledge of the use of technology..

Table 5. Component Analysis of TK

No	Teacher Code	TK Score(%)	Criterion Qualitative
1	G1	47	Sufficient
2	G2	41	Less
3	G3	43	Less
Average		43,6	Sufficient

Technological Content Knowledge (TCK)

Analysis of the ability of 3 teachers in technological content knowledge has an average score of 54.3% in the sufficient category. Table 6 shows varying abilities, respondent G1 has a score of 61% in the sufficient category, respondent G2 has a score of 62% in the sufficient category, and respondent G3 has a score of 40% in the insufficient category. Respondents have varying abilities in using technology..

Table 6. Component Analysis of TCK

No	Teacher Code	TCK Score (%)	Criterion Qualitative
1	G1	61	Sufficient
2	G2	62	Sufficient
3	G3	40	Less
Average		54,3	Sufficient

Technological Pedagogical Knowledge (TPK)

The analysis of teachers' abilities in three schools in the TPK aspect has an average score of 61.6%. Respondent G1 has a score of 61% in the sufficient category, G2 has a score of 65% in the good category, and G3 has a score of 59% in the sufficient category..

Table 7. Component Analysis of TPK

No	Teacher Code	TPK Score (%)	Criterion Qualitative
1	G1	61	Sufficient
2	G2	65	Good
3	G3	59	Sufficient
Average		61,6	Sufficient

Pedagogical Content Knowledge (PCK)

Analysis of the ability of 3 teachers in the PCK aspect has an average value of 51.3% in the sufficient category. Table 8 shows that respondent G1 has a score of 59% in the sufficient category, G2 has a score of 41% in the insufficient category, and G3 has a score of 54% in the sufficient category. From the data it can be seen that respondents have the ability to present diverse materials..

Table 8. Component Analysis of PCK

No	Teacher Code	PCK Score (%)	Criterion qualitative
1	G1	59	Sufficient
2	G2	41	Less
3	G3	54	Sufficient
Average		51,3	Sufficient

Technological Pedagogical and Content Knowledge (TPACK)

Analysis of the ability of 3 teachers in the TPACK aspect has an average of 49.6% in the sufficient category. Table 9 shows the percentage score of 3 respondents. Respondent G1 has a score of 46 in the sufficient category, G2 has a score of 44 in the sufficient category and G3 has a score of 59 in the sufficient category. From the data, it can be seen that 3 respondents have sufficient mastery of material integration, presentation and use of technology, but there must be maximum efforts in application in learning so as to improve learning outcomes and student motivation..

Table 9. Component Analysis of TPACK

No	Teacher Code	TPACK Score (%)	Criterion qualitative
1	G1	46	Sufficient
2	G2	44	Sufficient
3	G3	59	Sufficient
Average		49,6	Sufficient

Table 10. Average Score of each Component

No	Komponen CK	Average
1	Mastering the material being taught	4
2	Provide relevant examples to improve student understanding	4
3	Delivering material logically, clearly and in accordance with the lesson plan	3,4
4	Answering student questions appropriately	3,4
5	Using the latest sources such as books, journals, to increase the knowledge of biology.	4
Average		**3,8**
PK Component		
6	Has a variety of strategies / ways of instilling concepts to students	2,6
7	Use a variety of assessment methods and techniques that varies	2,3
8	Mastering and managing the class well	2,6
9	Taking reflective action to improve the quality of learning	2,6
Average		**2,6**
TK Component		
10	Mastering the technology used well	2,3
11	The technology used has an appeal appeal to students	2,3
12	The technology used successfully increase student interest and motivation	2,3
13	The technology used is easy to to operate	2
14	The technology used is in accordance with development of the times	2
15	The technology used is in accordance with the level of understanding of students	2,6
16	The technology used helps solve problems	2
Average		**2,2**
TCK Component		
17	The technology used is relevant to the material being taught	3
18	Technology used can improve student understanding	2,6

19	Develop student activities and tasks that involve the use of technology	2,3
Average		**3,3**
TPK Component		
20	Using computer applications in learning	3,3
21	Choosing technology that is appropriate to learning approaches and strategies	3
22	Using internet facilities to communicate with students for example to collect assignments or teaching materials.	3
Average		**3,3**
PCK Compenet		
23	Choosing learning approaches and strategies that are appropriate to the chemistry material being taught	2,3
24	Provide questions to measure student understanding about the material being taught	3
25	Preparing lesson plans by yourself and consulting with the Supervisor	2,3
Average		**2,5**
TPACK Component		
26	Choose learning strategies and technology that are appropriate to the chemistry material that will be used in learning activities	2,6
27	Integrate biological knowledge, pedagogical knowledge, and technological knowledge to realize effective learning. in realizing effective learning	2,3
28	Apply appropriate learning strategies and use various computer applications in learning implementation	2,6
Average		**2,5**

This data shows that the ability of each component of CK is categorized as sufficient with an average value of 3.8 in the Very Good category, PK is sufficient with an average value of 2.6, TK with an average value of 2.2 in the Less category, TCK with an average value of 3.3 in the Very Good category, TPK with an average value of 3.3 in the Very Good category, PCK with an average value of 2.5 in the Good category and TPACK with an average value of 2.5 in the Good category.

After analyzing the overall data, the average results of each aspect of TPACK are presented in Figure 1.

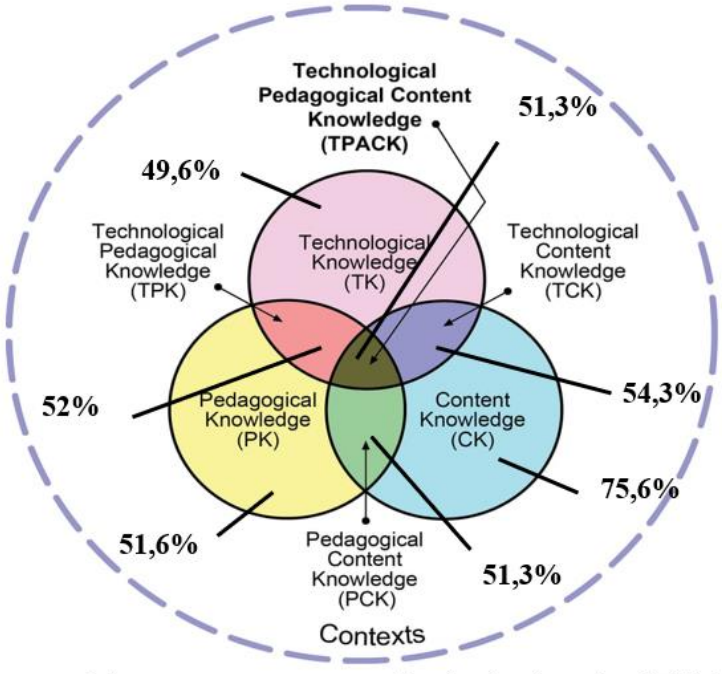

Figure 1. Diagram of the average percentage of high school teachers' TPACK skills

Figure 1 above can be seen that TPACK consists of several aspects combined into one, namely: technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), pedagogical content knowledge (PCK) and technological pedagogical knowledge (TPK).

5. Discussion

Based on the qualitative criteria in Table 1, the ability of high school teachers is classified as quite good for all TPACK components. The highest percentage is in the CK aspect with a score of 75.6%, while the lowest percentage is in TK which is 43.6%. The factor that causes the acquisition of the percentage of activities in the TK aspect is not good because there are still many teachers who cannot integrate TK, CK, and PK properly. This is in accordance with research conducted by (Schmidt et al., 2009), that all aspects of TPACK significantly affect the successful integration between TPACK and learning. TPACK is very important for the ability to develop learning tools, teachers can use technology well in learning activities, if teachers can integrate six types of knowledge into the learning tools they prepare (Harris & Hofer, 2011; Alharbi,2022). The results of this study are in accordance with the results of research conducted by Graham et al., (2009); Schmid et al., (2021); Yulisman, (2023) who examined TPACK abilities in teachers.

Research on TPACK has been conducted by Chai, Koh & Tsai (2016), the study reviewed 74 literatures including journals and articles related to TPACK. The results of the study indirectly stated that teachers need TPACK for effective learning in the classroom although more in-depth research on TPACK still needs to be done (Handayani et al, 2023; Fakhriyah al., 2022). The TPACK framework has a significant impact on teachers and educators. The TPACK framework describes the different types of knowledge that teachers need to teach effectively with the help of technology and various complex procedures regarding the field of knowledge interaction (Koehler et al., 2014; Malik et al., 2019; Sari et al., 2019; Schmidt et al., 2021). According to NCTM (2000), the use of technology in learning affects what is taught and when learning material appears in the curriculum. Therefore, teachers need to ensure that the use of technology in learning is effective (Prayudi et al., 2021; Shadaan & Eu, 2013; Ince-Muslu & Erduran,2021).

Some facts that affect teachers' TPACK abilities are the many learning experiences gained by the government with the aim of improving the quality of teachers. So that the length of teaching experience is not directly proportional to the improvement of TPACK ability. This is influenced by many factors, including the busyness faced by senior teachers, which causes senior teachers to not be able to take the time to learn new things, especially technological advances in supporting the teaching process in the classroom. Therefore, most senior teachers still apply conventional learning methods.

conventional learning methods. In contrast, teachers who have 11-15 years of teaching experience can transform their classrooms using technology. This is because teachers with 11-15 years of teaching experience are not as busy as teachers with 16 or more years of teaching experience.

6. Conclusion

Based on the results of the analysis of the TPACK ability of teachers in developing learning tools with a sample of 3 teachers of SMA Negeri 1 Kupang, it can be concluded that the TPACK ability of teachers is quite good with a score of technological knowledge (TK) of 43.6%, pedagogical knowledge (PK) of 52%, Content knowledge (CK) of 75.6%, Technological content knowledge (TCK) of 53.3%, pedagogical content knowledge (PCK) of 51.3%, technological pedagogical knowledge (TPK) of 61.6% and TPACK of 49.6%. The utilization of information and communication technology in learning can be an alternative for these improvements. To be able to integrate information and communication technology in teaching, a Technological Pedagogical Content Knowledge (TPACK) framework is needed by a teacher. Therefore, teachers in Indonesia should have this ability in order to realize the goals of National education so that the Indonesian nation can compete with other nations in the current era of the Asean Economic Community (AEC).

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