



# Identification of TPACK-ICT Jayapura City High School Biology Teachers in Facing Post-Pandemic Learning

Tanta<sup>1</sup>, Maik Akobiarek<sup>1</sup>, Suriyah Satar<sup>1</sup>, Hanida Listiani<sup>1</sup>, Nurbaya<sup>1\*</sup>

<sup>1</sup>Department of Biology Education, Faculty of Teacher Training and Education, Universitas Cenderawasih, Papua, Indonesia.

Received: October 19, 2023

Revised: November 14, 2023

Accepted: December 20, 2023

Published: December 31, 2023

Corresponding Author:

Nurbaya

[nurbaya@fkip.uncen.ac.id](mailto:nurbaya@fkip.uncen.ac.id)

DOI: [10.29303/jppipa.v9i12.6119](https://doi.org/10.29303/jppipa.v9i12.6119)

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**Abstract:** TPACK-ICT components by Biology Teachers, this research was carried out with the aim of identifying the Technological Pedagogical Content Knowledge Information and Communication Technology (TPACK-ICT) components of High School Biology Teachers in Jayapura City. The research method used in this research is mixed methods. The sample used in this research was 12 Biology teachers in the city of Jayapura using a sampling technique, namely convenience sampling from the population, namely all teachers of public high schools and private high schools in the city of Jayapura. Quantitative data in this research was obtained using questionnaires using Likert scale 1 to 5 containing 30 statements related to TPACK-ICT with supporting data using an interview guide. The data obtained was then analyzed using quantitative and qualitative approaches. After conducting the analysis, the results showed that the TPACK competency of high school Biology teachers in the city of Jayapura was classified as good for all TPACK components. The average score in each aspect, namely TK, CK, PK, PCK, TCK, TPK, and TPACK is in the medium category, this indicates that biology teachers at Jayapura City High Schools are ready to face post-pandemic learning with their competencies.

**Keywords:** Biology Teacher; Jayapura; TPACK-ICT

## Introduction

The continuity of the world of education in the 21<sup>st</sup> century has unique regulations, especially in terms of implementing learning. Integrating ICT (Information, Communication and Technology) in every level of education is a necessity to face progress in the digital era (Almenara & Díaz, 2012). The development of technology and information has a significant impact on various aspects of life, starting from lifestyle, ways of associating, and especially teaching and learning activities (Fombona et al., 2020). The provision of technological equipment by the government and balanced with the phenomenon of students who are already accustomed to technology, directs teachers to use ICT in the classroom. Research related to technology integration in the learning process reveals quite significant results. The use of ICT is able to create an effective learning environment and actively involve students, so that the implementation of ICT is not only

limited as a strategy but can be the best instrument for teachers in achieving learning goals (Agbo, 2015; Granados & Jaramillo, 2019).

The urgency of ICT involvement in learning is emphasized by the 2019 Corona Virus pandemic and the current Post-Pandemic Covid-19. During the pandemic, face-to-face activities were eliminated and replaced with a learning system that was fully facilitated by technology. After the pandemic ended, teachers and students returned to school, but the use of technology was increasingly encouraged by the government. The application of ICT in post-pandemic learning is expected to be able to present interesting discussion topics, provide fast learning feedback, diagnose student learning needs, provide effective ways to remediate student learning difficulties, assess student learning processes and outcomes or store examples of student work, which will be used to improve learning outcomes, with the main characteristics being multimedia-based involving text, images, sound and video (Villar et al.,

## How to Cite:

Tanta, Akobiarek, M., Satar, S., Listiani, H., & Nurbaya. (2023). Identification of TPACK-ICT Jayapura City High School Biology Teachers in Facing Post-Pandemic Learning. *Jurnal Penelitian Pendidikan IPA*, 9(12), 11705–11713. <https://doi.org/10.29303/jppipa.v9i12.6119>

2022; Moral & de Benito, 2021). It can be seen that the fundamental knowledge of a teacher in integrating technology in the learning process is really needed.

Teachers' knowledge in selecting material, implementing ICT and transforming knowledge to students is called Technological Pedagogical Content Knowledge (TPACK) (Chai et al., 2013; Koehler & Mishra, 2009). In other words, TPACK is the teacher's expertise in integrating information and communication technology into learning activities. There are seven variables that influence TPACK, namely: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Pedagogical and Content Knowledge (TPACK) (Chai et al., 2013; Hsu et al., 2021; Koehler & Mishra, 2009; Mishra & Koehler, 2006; Papanikolaou et al., 2017; Schmidt et al., 2009; Tømte et al., 2015).

The use of multimedia within the TPACK ICT framework is very important in supporting the learning process in the classroom, especially for Biology subject teachers. The complexity of biological material that studies living things from the micro to the macro level requires technological visualization so that students understand the learning content accurately (Delgado-Rodríguez et al., 2023; Kareem, 2018). Research related to TPACK ICT in Jayapura among Biology Teachers can be said to be still minimal in number, but the urgency to carry it out is high, so that it can be seen mapping the mastery of TPACK ICT components by Biology Teachers. With this background, this research proposal was submitted with the aim of "Identifying how to master the Technological Pedagogical Content Knowledge Information and Communication Technology (TPACK ICT) components of Jayapura City High School Biology Teachers.

## Method

This research was conducted on biology teachers in public high schools and private high schools in Jayapura City. The research was carried out from April to August 2023. The research method used in this research was Sequential Explanatory mixed methods. Explanatory sequential mixed methods are mixed methods with a strong quantitative background to a qualitative approach (Parmin & Savitri, 2022). The population used in this research were all public and private high school teachers in Jayapura City. The samples involved in this research were 12 biology teachers who taught at public high schools and private high schools in Jayapura City. The sample collection technique used was convenience sampling (Riduan & Akdon, 2006).

Quantitative data in this research was obtained using a questionnaire with a Likert scale of 1 to 5 containing 30 positive statements related to TPACK-ICT. The TPACK-ICT questionnaire used in this research came from an article written by Koh et al. (2010). The TPACK-ICT instrument uses a Likert scale (point 1: very poor to point 5: very good). This research questionnaire was distributed to respondents in the form of a Google form via Whatsapp. Meanwhile, qualitative data regarding how teachers integrated technology in learning in this research was obtained through interviews.

The questionnaire data obtained was then analyzed by calculating each statement item. Next, determine the percentage value for each item in the TPACK-ICT competency statement value. The next stage is to convert the percentage value to the TPACK-ICT competency category (Purwanto, 2010; Riduan & Akdon, 2006) as stated in the following table:

**Table 1.** Interpretation of TPACK-ICT Scores

Interval (%)	Category
81-100	Very high
61-80	High
41-60	Medium
21-40	Low
0-20	Very low

## Result and Discussion

TPACK (Technological, Pedagogical, Content Knowledge) is a framework for designing new learning models by combining three main aspects, namely technology, pedagogy and content knowledge (ontological) (Quddus, 2019). Ideas related to TPACK have spread and been adopted by many countries in the world as an effort to improve teachers' abilities in integrating information communication technology (ICT) (Chai et al., 2013). In developed countries, the integration of technology, pedagogy and content in the form of learning tools with the theme TPACK is used as a creative solution developed in the learning context (Fitriyana et al., 2021; Gamez & Mayorga-Fernández, 2022). There are seven indicators in TPACK, namely Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK).

*Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK)*

The results of the recapitulation of the TPACK-ICT questionnaire for the Technological Knowledge (TK),

Pedagogical Knowledge (PK), and Content Knowledge (CK) components are shown in Table 2.

Technological Knowledge (TK) is knowledge for prospective teachers and teachers to know technology, software or applications that can be used to support the learning process (Sintawati & Indriani, 2019). Technological knowledge (TK) abilities in this research include 8 statement items including skills to know how to solve technical problems on computers, know how to find it easy to use technology, know how to follow the latest technological developments, know the basic components of a computer, know how to use word

processing programs, numbers and presentation programs, know how to operate using printers, scanners, projectors and digital cameras, know how to save data on digital media; and know how to use the internet as a communication medium. Based on Table 1, the data shows that Technological Knowledge (TK) ability is in the medium category, with the highest questionnaire score obtained on questionnaire scale 3 (fairly good), namely 47%. Of course, this capability must continue to be improved so that it can keep pace with modernization in the world of education.

**Table 2.** Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK)

Indicator	Item	Likert Scale (n=12)				
		1	2	3	4	5
TK	1. I know how to solve technical problems on computers	0	2	6	4	0
	2. I find it easy to use technology	0	0	7	4	1
	3. I follow the latest technological developments	0	0	5	5	2
	4. I have an understanding of the basic components of a computer	0	2	7	2	1
	5. I am proficient in using word processing programs, numbers and presentation programs	0	2	7	1	2
	6. I am proficient in using printers, scanners, projectors and digital cameras	0	0	6	3	3
	7. I save data on digital media	0	0	4	5	3
	8. I use the internet as a communication medium	0	0	3	3	6
	Total	0 (0%)	0.75 (6%)	5.62 (47%)	3.37 (28%)	2.25 (19%)
CK	9. I understand the concepts, laws and theories taught	0	0	3	6	3
	10. I know the history of the development of the material being taught	0	0	4	7	1
	11. I design and implement learning	0	0	2	6	4
	12. I use the latest sources such as books and journals	0	0	2	7	3
	13. I take part in seminars or activities related to the field of science taught	0	1	4	6	1
		Total	0 (0%)	0.2 (1.6%)	3 (25%)	6.4 (53.3%)
PK	14. I apply varied learning	0	0	3	6	3
	15. I am able to manage and control the class well	0	0	4	4	4
	16. I use a variety of assessment methods and techniques	0	0	3	6	3
	17. I take reflective action to improve the quality of learning	0	0	3	7	2
		Total	0 (0%)	0 (0%)	3.25 (27.08%)	5.75 (47.91%)

Furthermore, if we look at the average ability of biology teachers in Jayapura city high schools for all statement items, it can be concluded that the teachers' Technological Knowledge (TK) ability is in the good category. Biology teachers have also applied Technological Knowledge (TK) skills with learning. This can be seen from the results of interviews that biology teachers have implemented technology such as projectors, computers and cellphones to support learning. Teachers also use various media such as Power Point, Google Forms, videos from YouTube and so on. Mastery of technology is expected to become a basic skill for teachers and prospective teachers so they can present

interesting, creative and motivating learning for students (Armiyati & Fachrurozi, 2022; Nasution, 2018). Based on the results of interviews, there are several technologies that have been implemented by biology teachers, such as projectors, laptops/computers and cellphones. Teachers also use various media such as Power Point, Google Forms, videos from YouTube and so on. These results show that biology teachers have the ability to master technology well so that they are able to support the learning process well, but there are some teachers who still need to improve their Technology Knowledge (TK) competency so that the learning process can take place optimally.

Content Knowledge (CK) is knowledge about the teaching material that will be studied by students and teachers must master this teaching material broadly and deeply so that it can be delivered and received correctly by students (Koehler & Mishra, 2009). Content knowledge (CK) abilities in this research include 5 statements, that indicates the ability to understand the concepts and theories being taught, know the history of the development of the material being taught, know how to design and implement learning, know how to use the latest sources such as books and journals, and take part in seminars or activities related to the field of science taught. Content knowledge (CK) capability for each statement item is in the good category.

The teacher has mastered Content Knowledge (CK) skills for each statement item well. Furthermore, if we look at the average ability of biology teachers in Jayapura City High Schools for all statement items, it can be concluded that the Content Knowledge (CK) abilities of Jayapura City High School biology teachers are in the medium category, with an accumulation of 53.3% of respondents giving a self-assessment on a scale of 4 (Good). Teachers' and prospective teachers' understanding of the material is very important because it is related to the depth and delivery of the material to students (Ammade et al., 2020; Armiyati & Fachrurrozi, 2022; Hardisky, 2018). Based on the results of interviews conducted with biology teachers, it is known that teachers always carry out curriculum analysis in designing learning tools and looking for appropriate material sources to provide to students. These results indicate that respondents have the ability to master the material well and teach it to students well, but there are some teachers who still need to improve their Content Knowledge (CK) competency so that the knowledge transfer process can take place optimally.

Pedagogical Knowledge (PK) is knowledge related to teaching and learning theory which consists of processes, objectives, strategies, methods and models of learning, assessment and so on. Apart from that, it also consists of knowledge in managing classes, recognizing student characteristics, and developing learning plans (Villar et al., 2022). The Pedagogical Knowledge (PK) indicator has 4 statement items that indicate the ability to apply varied learning, ability to to manage and control the class well, ability to use various assessment methods and techniques, and ability to take reflective action to improve the quality of learning. The biology teacher's Pedagogical Knowledge (PK) ability for each statement item is in the good category.

Furthermore, if we look at the average ability of biology teachers in Jayapura City High Schools for all statement items, it can be concluded that the Pedagogical Knowledge (PK) abilities of Jayapura City

High School biology teachers are in the medium category (47.91%), with the highest accumulation of questionnaires on a Likert scale of 4 (Good). Based on the results of interviews, Pedagogical Knowledge (PK), including the use of power points and Google forms in implementing varied learning methods. These results indicate that biology teachers have the ability to utilize various media to support the achievement of learning objectives in the classroom. Of course, this competency must continue to be improved so that it can keep pace with modernization in the world of education. The three components of TPACK, namely Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) are at a medium level with the intention that teacher abilities must be improved.

*Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) Technological Pedagogical Knowledge (TPK)*

The results of the recapitulation of the TPACK framework questionnaire, consisting of three components of the body of knowledge Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) Technological Pedagogical Knowledge (TPK) (Hu & Fyfe, 2010), can be seen in Table 3.

This research shows that the Pedagogical Content Knowledge (PCK) competency of Jayapura Public and Private High School Biology teachers is in the medium category, with a questionnaire score of 52.08% (on a Likert scale of 3: quite good). Pedagogical Content knowledge (PCK) is knowledge related to content in the learning process and curriculum. The Pedagogical Content Knowledge (PCK) indicator consists of 4 items, that indicates the ability to choose learning approaches and strategies that are appropriate to the existing learning material, the ability to prepare the lesson plan myself, the ability to measure students' understanding of the material being taught, and the ability to know the correct flow of presenting the material and it tends to be easier for students to understand.

According to Archambault et al. (2010), Pedagogical Content knowledge (PCK) consists of five components, namely, teaching orientation (knowledge about the content of the subject matter and confidence in understanding the material and how to teach it), knowledge about the curriculum (what and when to teach), knowledge about assessment (why, what, and how to assess), knowledge about students' understanding of the content of the subject area, and knowledge about learning strategies. This is different at each level of education, from elementary school to middle school. Teachers can apply Pedagogical Content Knowledge (PCK) by reflecting after teaching, interviews or dialogue with students, discussions with

other teachers, supporting activities such as seminars, classroom action research, courses, joining professional organizations, writing in journals and mass media.

The next aspect measured in this research is Technological Content Knowledge (TCK). TCK competency, based on Table 3, is at medium level (52.7%) at Likert scale point 4 (good). The Technological Content Knowledge (TCK) indicator describes knowledge of the reciprocal relationship between technology and content (material) (Angeli & Valanides, 2009). Technological Content Knowledge (TCK) in this

research consists of 3 items, that elaborate the skills of using technology to help understand concepts of learning material, the skill of how to use computer applications related to the material being taught, and have the knowledge in developing student activities and assignments that involve the use of technology. Technology has an impact on what we know and the introduction of new things regarding how we can describe content (material) in different ways that were previously impossible (Martín et al., 2020; Heemskerk et al., 2011; Kareem, 2018).

**Table 3.** Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) Technological Pedagogical Knowledge (TPK)

Indicator	Item	Likert Scale (n=12)				
		1	2	3	4	5
PCK	18. I choose learning approaches and strategies that are appropriate to the existing learning material	0	2	6	4	0
	19. I prepare the lesson plans myself	0	0	7	4	1
	20. I measure students' understanding of the material being taught	0	0	5	5	2
	21. I know the correct flow of presenting material and it tends to be easier for students to understand	0	2	7	2	1
	Total	0 (0%)	1 (8.30%)	6.25 (52.08%)	3.75 (31.25%)	1 (1%)
TCK	22. I use technology to help understand concepts, laws and theories of learning material	0	0	3	6	3
	23. I know computer applications related to the material being taught	0	0	4	7	1
	24. I am knowledgeable in developing student activities and assignments that involve the use of technology	0	0	2	6	4
	Total	0 (0%)	0 (0%)	3 (25%)	6.3 (52.70%)	2.6 (22.20%)
TPK	25. I use computer applications such as Microsoft Word, Power Point in learning or teaching practice	0	0	3	6	3
	26. I choose technology that is appropriate to the learning approaches and strategies in the learning practices that the teacher implements	0	0	4	4	4
	27. I use internet facilities such as social media, blogs as learning media	0	0	3	6	3
	Total	0 (0%)	0 (0%)	3.3 (27.70%)	5.3 (44.40%)	3.3 (27.70%)

Technological Pedagogical Knowledge (TPK) is a competency that is measured in the TPACK framework. Technological Pedagogical Knowledge (TPK) identifies the reciprocal relationship between technology and pedagogy (Lambert & Gong, 2023). The results of the research show that the TPK competence of Biology teachers at Public and Private High Schools in Jayapura Subah is at medium level (44% of respondents chose item 4-good on the Likert scale). Technological Pedagogical Knowledge (TPK) consists of 3 items that explain the ability to use computer applications such as Microsoft Word, Power Point in learning or teaching practice, the ability to choose technology that is in accordance with the learning approach and strategy in

the learning practices that the teacher implements and, and the ability to use internet facilities such as social media, blogs as learning media. This Technological Pedagogical Knowledge (TPK) makes it possible to understand what use of technology is appropriate to achieve pedagogical goals, as well as enabling teachers to choose what equipment is most appropriate based on its suitability for a particular pedagogical approach. Technology can also provide new methods for teaching that are easier to implement in the classroom (Fernández-Morante et al., 2023; Gamez & Mayorga-Fernández, 2022; Infante-Moro et al., 2019).

Most teachers have used computer applications such as Microsoft Word, Power Point in learning or

teaching practice, have been able to choose technology that suits the learning approach and strategy in the learning practice that teachers carry out and have been able to use internet facilities such as social media, blogs for learning media (Salcines-Talledo et al., 2020). Based on the results of interviews conducted with biology teachers, it is known that biology teachers have adjusted the material and pedagogy before preparing the tools so that the tools created are in accordance with the students' initial abilities. It can also be seen from the results of teacher interviews that the teacher in delivering material to students is in line with the students' initial understanding. However, biology teachers' PCK, TCK, and TPK abilities must continue to be improved to make it easier to achieve learning goals and educational goals nationally.

From the research, it can be seen that the competencies of PCK, TCK, and TPK are in the good category. A study conducted by Papanikolaou et al. (2017) stated that the three elements of TPACK knowledge are interrelated with teacher competence in integrating technology and pedagogy in the teaching and learning process. Even though it has been classified as very good, these competencies still need to be improved. This also applies to biology teachers who feel that their competence is still lacking so that they continue to improve their competence so that later this competence can help biology teachers in teaching so that learning can take place optimally.

*Technological Pedagogical Content Knowledge (TPACK)*

The results of the recapitulation of the TPACK-ICT questionnaire) are shown in Table 4.

**Table 4.** Technological Pedagogical Content Knowledge (TPACK)

Indicator	Item	Likert Scale (n=12)				
		1	2	3	4	5
TPACK	28. I choose learning strategies and technology that are appropriate to the material that will be presented in practical learning activities	0	0	3	6	3
	29. I combine my technological knowledge to create effective learning	0	0	3	6	3
	30. I apply different learning strategies and use various computer applications in implementing learning practices	0	1	4	5	2
	Total	0 (0%)	0.3 (2.70%)	3.3 (27.70%)	5.6 (47.70%)	2.6 (22.20%)

Technological Pedagogical Content Knowledge (TPACK) is knowledge about the complex interaction of the three aspects involved in learning in today's modern era (content, pedagogy, technology). Learning in the modern era requires teacher understanding to be able to collaborate pedagogy and content with technology. Teachers must have an understanding of the complex interactions between the 3 basic components, namely PK, CK, and TK by teaching the material using appropriate pedagogical and technological methods (Mishra & Koehler, 2006). TPACK will have an impact on teachers considering that the relationship between technology, pedagogy and content is not can be separated. So that in the future teachers will face greater challenges that are directly proportional to technological developments. Teachers should become more aware of technology and actively develop and design learning tools and activities.

Evaluation of the ability of biology teachers at SMA Jayapura City in the TPACK aspect is in the medium category (47.7%). From these data it can be seen that of the 7 TPACK components assessed for teacher pedagogy and content are in the good category, although there are still 3% in the poor category. Based on qualitative

criteria, the TPACK competency of high school Biology teachers in the city of Jayapura is classified as good for all TPACK components. The average scores for each aspect, namely TK, CK, PK, PCK, TCK, TPK, and TPACK are 3.59, 3.92, 3.98, 3.96, 3.75, 4.14, and 3.89 respectively, all categories are in the good category (Ammade et al., 2020; Tømte et al., 2015). This is in accordance with research conducted Hardisky (2018), that all aspects of TPACK significantly influence the success of integration between TPACK and learning. TPACK is very important for the ability to compile learning tools, teachers can use technology well in learning activities, if teachers can integrate six types of knowledge into the learning tools they prepare (Hsu et al., 2021).

Research on TPACK has been conducted by Chai et al. (2013), the TPACK Framework has had a significant impact on teachers and educators. The TPACK framework describes the various types of knowledge that teachers need to teach effectively with the help of technology and various complex procedures regarding the areas of knowledge interaction. According to Fernández-Morante et al. (2023), the use of technology in learning influences 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. Based on research by Ammade et al. (2020) and Tømte et al. (2015), several facts that influence teachers' TPACK abilities are the amount of learning experience they have gained. This relates to data obtained from 12 high school biology teachers in the city of Jayapura, 11 of whom have obtained educational certificates.

## Conclusion

The TPACK competency of high school Biology teachers in the city of Jayapura is classified as good for all TPACK components. The average score in each aspect, namely TK, CK, PK, PCK, TCK, TPK, and TPACK respectively, is in the medium category, this indicates that biology teachers in Jayapura City High Schools are ready to face post-pandemic learning with the competencies they have, but some aspects need improvement.

## Acknowledgments

The author would like to thank all biology teachers in Jayapura and that helped in this research.

## Author Contributions

T. T., M. A.; Methodology, T. T.; Validation, M. A and S. S.; Formal analysis, T. T.; Investigation, H. L. and N.; Formal analysis, M. A. and N.: Writing—original draft preparation, T. T and N.; Writing—review and editing, T. T. and S. S.; Supervision, M. A.; Project administration, T. T.; Funding acquisition. All authors have read and agreed to the published version of the manuscript.

## Funding

This research was funded by Faculty of Teacher Training and Education of Universitas Cenderawasih.

## Conflicts of Interest

The authors declare no conflict of interest.

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