Studies in Learning and Teaching (SiLeT)
Homepage: https://scie-journal.com/index.php/SiLeT
Email: silet@scie-journal.com

p-ISSN: 2722-399X; e-ISSN: 2722-1857
SiLeT, Vol. 4, No. 2, August 2023
Page 240-249
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Technological Pedagogical Content Knowledge (TPACK) Prospective Biology Teachers in Distance Learning

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Article Info

Article history:

Received February 8, 2023
Revised May 15, 2023
Accepted July 6, 2023
Available Online August 31, 2023

Keywords:

Biology learning;
Pedagogy knowledge;
Content knowledge;
Technological knowledge;

ABSTRACT

Although much research has been done on TPACK, there is still nothing that examines TPACK for potential distance learning teachers. This study aims to determine the TPACK ability possessed by prospective biology teachers in distance learning through three main aspects, namely Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). The research method used is the quantitative descriptive method. Research subjects were determined using the purposive sampling technique. Data was collected through TK, CK, and PK observation sheets; distance learning videos for prospective biology teachers; lesson plans; assessment sheets; and documentation. The result of data analysis shows that the TK ability of prospective biology teachers is within good criteria with a percentage of 80%, the PK ability of prospective biology teachers is within good standards with a rate of 77.27%, and the CK abilities of prospective teachers are within good criteria with a percentage of 80.94%. So, it can be concluded that the three aspects of TPACK for prospective biology teachers are reasonable criteria. The highest interpretation is on the ability of TK, and the lowest performance is on the knowledge of PK. The findings of this study are recommended for universities, especially in developing the TPACK abilities of prospective teachers.

https://doi.org/10.46627/silet

INTRODUCTION

The world of education has entered the era of 4.0 following the development of the fourth generation industrial revolution era due to the impact of the rapid development of science and technology (Science And Technology) (Lase, 2019). The rapid development of technology is giving rise to many changes in various fields, one of which is in the field of education. Experts use the term 4.0 to describe how to implement technology into learning (Lase, 2019). In addition, the world of education is currently facing challenges due to the impact of the COVID-19 virus pandemic. This leads to the entire educational institution being It is not to carry out face-to-face learning activities so that distance learning becomes a characteristic of the learning process. In accordance with the policies taken by the government in addressing the limitations of education due to the COVID-19 virus, where the learning process is carried out online or remotely (Kemdikbud, 2020).

In this case, the role of teachers is needed in the learning process. Teachers are required to have the ability to master technology and be able to integrate it into the learning process, following Permendiknas No. 16 of 2017 on Academic Qualification Standards and Teacher Competence, which states that teachers should utilize information and communication technology for learning purposes. However, in its application, teachers face various challenges

in the use of technology, especially in distance learning today. Among them is the unpreparedness of teachers to master technology (Surahman et al., 2020). Technological Pedagogical Content Knowledge (TPACK) is formulated as a conceptual framework that emphasizes relationships, interactions, and constraints between the three main components of content, pedagogy, and technology (Mishra & Kohler, 2006). This TPACK framework describes the three components of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), which are integrated as a synthesis of knowledge that is most effectively used by teachers in learning (Mishra et al., 2011). TPACK focuses on three main components: content, pedagogical, and technological (Koehler et al., 2013), the three components are integrated to realize holistic learning in the 21st Century. Knowledge of technological pedagogical content emerges as a conceptual framework for conceptualizing teachers' understanding of efficient technology integration (Ocak, 2019). The complexity of teaching and learning that emerges in technologically enhanced classrooms is addressed by TPACK. TPK makes a strong prediction of TPACK, whereas PK makes a significant prediction of TPK. Similar to this, PCK is also strongly predicted by PK. The most accurate prediction by TK is TCK (Habibi, 2020). Teachers frequently need to possess sufficient pedagogical, subject, and technological knowledge in order to effectively integrate technology into the classroom (C S Chai, 2019) The intermediary factors TCK and TPK have a direct impact on TPACK, while TK has an impact on TPACK via TPK and TCK. TK, PK, and CK cannot predict TPACK. Teachers in Taiwan's (Chen, 2019) research received the highest marks.

The importance of TPACK capabilities has not been in line with the facts found in the field. Due to teachers' relatively low skills (Irdalisa & Amirullah, 2020), there is still a need to improve their TPACK skills in a globalized world. Based on the study results (Sukaesih et al., 2017), it is also stated that the ability of TPACK prospective teachers still needs to be improved in some aspects of content mastery, pedagogy, and technology. This was conveyed by Drajati (Pahlevi et al., 2021) that teachers have not integrated TPACK into distance learning. TPACK's ability is needed to develop the professionalism of teachers and prospective teachers to produce qualified and competent educators. The ability of TPACK prospective teachers becomes very important as an initial picture of pedagogical competence, mastery of content or material, and technology of prospective teachers before carrying out direct learning in school (Sukaesih et al., 2017). In addition, the delivery of distance learning requires educators to use technology as a learning center, so that the ability of TPACK teachers and prospective teachers is needed to achieve learning goals. Putting TPACK into distance learning is a good idea (Pahlevi et al.,2021).

Prospective teachers who are prepared to become professional teachers should have good TPACK skills so that when in class, prospective teachers can apply it well. So, the goal of this study is to find out how much students who want to become biology teachers know about TK, PK, and CK (Technological Knowledge, Pedagogical Knowledge, and Content Knowledge) in online internship III activities that involve distance learning.

RESEARCH METHOD

This research uses quantitative descriptive methods by describing the ability of TPACK students aspiring to be biology teachers in distance learning in aspects of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). Research samples are used using purposive sampling techniques. The chosen sample is the chairman of the group, who is a representative of each of the 20 internship group III biology education students of Muhammadiyah University Prof. Dr. Hamka. These 20 people will be watched as research subjects using tools for collecting data. Frequently used qualitative data are descriptive statistics (Evrim Baran et al., 2019) questionnaires and demographic data (Nelson et al., 2019).

Research Then, create a research instrument that will be used to collect data as well as validate the tool through expert judgment instruments with expert lecturers. Furthermore, the implementation stage begins by determining the research sample and taking care of the research license to the internship school. In this case, the request is used to conduct research by

https://doi.org/10.46627/silet.v4i1.191

asking teachers and guidance lecturers to become observers of research. After that, data collection is carried out for prospective biology teacher students at the time of internship III, starting with the filling of observation sheets by observers through Google Form, data collection in the form of distance learning videos of internship III activities, as well as the necessary documentation data, and the filling of observation sheets by researchers. After all the data is collected, the researchers analyze the research data, describe the results, and discuss the results of the study by checking the validity of the data obtained with other data and theories used, then making conclusions from the data about the results of the research that has been obtained.

The data collection techniques used are observation, RPP assessment, and documentation. Data analysis techniques are used for quantitative and descriptive data analysis techniques. Data analysis is based on the research data collected using assessment results on TK observation sheets, CK, PK, and RPP assessment, and distance learning video analysis. Data processing procedures begin by systematically organizing data by code-giving or grouping data based on aspects of TPACK. Furthermore, the data generated from research instruments in the form of observation sheets and RPP assessment sheets using the Likert scale is presented in the form of percentage descriptions by calculating the number of scores obtained and converting them into percentage form using the following formulas:

$$Value = \frac{\text{Score Obtained}}{\text{Maximum Score}}\ x\ 100\ \%$$

The data obtained is further converted into qualitative criteria in table 1:

Table 1. Percentage Criteria for TPACK Ability of Prospective Biology Teachers in Distance Learning

Percentage	Criteria
86 – 100%	Excellent (A)
76 – 85%	Good (B)
60 – 75%	Enough (C)
55 – 59%	Less (D)
≤ 54%	Less Once (E)

(Purwanto, 2019)

Furthermore, the results of processing the data obtained are interpreted into desriptive sentences, and finally the conclusion/verification is carried out.

RESULTS AND DISCUSSION

Technological Knowledge (TK)

Technological Knowledge (TK) or technological knowledge is an educator's knowledge of technological knowledge consisting of an application, how to overcome it, and its development for the world of education (Anggara, 2018). The ability of TK aspiring biology teachers is measured using instruments in the form of TK observation sheets consisting of 2 indicators, namely 1) mastery of ICT-based learning media and 2) utilization of ICT-based learning media. The following table shows the results of processing TK data on prospective biology teachers who want to teach from a distance.

Table 2. Results of Technological Knowledge Assessment (TK)

No.	Prospective teachers	Indicator		Value (%)	Criteria
		TK.A	TK.B		
1	MM1	15	37	72.22	C
2	MM2	16	40	22.78	B
3	MM3	17	47	88.89	A
4	MM4	20	52	100	A
5	MM5	16	40	77.78	B
6	MM6	20	42	86.11	A
7	MM7	16	46	86.11	A

https://doi.org/10.46627/silet.v4i1.191

8	MM8	19	50	95.83	A
9	MM9	17	44	84.72	B
10	MM10	15	40	76.39	B
11	MM11	19	43	86.11	A
12	MM12	13	33	63.89	C
13	MM13	14	34	66.67	C
14	MM14	17	47	88.89	A
15	MM15	13	38	70.83	C
16	MM16	15	46	84.72	B
17	MM17	14	32	63.89	C
18	MM18	14	39	73.61	C
19	MM19	13	36	68.06	C
20	MM20	17	46	87.5	A
	Total	320	832		
	Average (%)	80	80	80	B

Indicator Description: TK.A is Mastery of ICT-based learning media and TK.B is Utilization of ICT-based learning media. Data assessment of the ability of TK prospective biology teachers on distance learning based on table 2 is generally on good criteria with a percentage of 80%; of the 20 prospective teachers, there are eight prospective teachers who are on very good criteria, five prospective teachers with good criteria, and seven prospective teachers with sufficient criteria, and there are no teacher candidates who are on the criteria less and less at all.

On the TK A indicator indicates that prospective biology teachers already have mastery of ICT-based learning media with a percentage of 80%, meaning that prospective biology teachers are able to choose ICT-based learning media that are effective in distance learning and already use more than one learning media. But in delivering the material, prospective biology teachers still use simple technology; namely, all prospective teachers use PowerPoint because the media is very effectively used to convey material in detail in distance learning. This is in line with research (Purwanti et al., 2020), which says that the use of media power points is considered the most likely medium to support the implementation of distance learning during the COVID-19 pandemic so that learning goals are also achieved. Also, almost all people who want to be teachers are already able to make attractive ICT-based learning media designs with the right content, even though the learning media that has been made is still simple and hasn't changed much.

On the TK.B indicator, prospective biology teachers have been able to utilize ICT-based learning media well, with a percentage of 80%. Based on the learning video, it is seen that the media function chosen by prospective teachers is in accordance with the purpose of learning and has been able to support all distance learning activities in a festive and conducive manner; this is seen from the implementation of all learning activities and the number of student attendance following learning. The learning media used by prospective biology teachers, in general, have also been able to attract the interest and motivation of learners. However, the results of the study show that, in general, ICT-based learning media used by prospective biology teachers have not been able to increase the activity and creativity of learning learners well. This is because almost all prospective biology teachers have not been able to used various types of innovative media into learning according to Salsabila et al. (2020), so prospective teachers' still needs to be improved (Irdalisa, 2022), and has not been utilized optimally (Absari, 2022). Technology also has a role in increasing the creativity of educators and learners, where educators must innovate in the delivery of materials with various social media sites. TK enables teachers to understand information technology and apply it correctly to achieve optimal learning, be able to identify the use of technology, and continue to adapt to technological changes (Ritonga, 2022).

Pedagogical Knowledge (PK)

Pedagogical Knowledge (PK), or the pedagogical ability of prospective biology teachers, is an ability that covers the entire learning process. PK's ability is measured based on the ability of

prospective teachers to design learning plans, carry out learning, and evaluate learning. This fits with the theory (Schmidt et al., 2009), which says that pedagogical knowledge includes knowledge of how to run a classroom, how to test students, how to make lesson plans, and how students learn. This process relates to the manner and process of teaching which includes knowledge of classroom management, assignments, lesson planning, and student learning (Hudson, 2007; Elvianasti, 2019).

The PK prospective biology teacher is measured by the PK observation sheet and the RPP assessment sheet. The PK observation sheet consists of 2 indicators, namely 1) ability to implement learning and 2) ability to evaluate learning. The results of processing PK observation data of prospective biology teachers on distance learning based on observation sheets are presented in the following table.

Table 3. Pedagogy Knowledge Assessment (PK)

No.	Prospective teachers	Indicator		Value (%)	Criteria
		PK.A	PK.B		
1	MM1	26	11	77.08	B
2	MM2	24	12	75	C
3	MM3	28	15	89.58	A
4	MM4	31	16	97.92	A
5	MM5	26	10	75	C
6	MM6	25	12	77.08	B
7	MM7	27	13	83.33	B
8	MM8	30	14	91.67	A
9	MM9	32	12	91.67	A
10	MM10	27	14	85.42	B
11	MM11	24	11	72.92	C
12	MM12	21	7	58.33	D
13	MM13	26	8	70.83	C
14	MM14	26	12	79.17	B
15	MM15	23	11	70.83	C
16	MM16	27	13	83.33	B
17	MM17	20	10	62.5	C
18	MM18	24	12	75	C
19	MM19	22	11	68.76	C
20	MM20	28	13	85.42	B
	Total	517	237		
	Average (%)	80.78	74.06	78.54	B

Indicator Description: PK. A is Ability to learn and PK. B is Ability to evaluate learning. PK's ability of prospective biology teachers based on RPP assessment based on table 3 is generally on good criteria with a percentage of 76%. PK's ability of prospective teachers, in general, is on good criteria with an average percentage of 77.27%. However, PK's ability of prospective biology teachers has the lowest interpretation compared to TK and CK's ability. This shows that prospective biology teachers already have good pedagogical skills but still demand improvement in the PK.A indicator of the shortage of prospective teachers lies in the lack of application of scientific approaches. Pedagogical skills can be consistently trained to prospective teachers so that they can choose appropriate learning methods and models (Elvianasti, 2018). This can be done through teaching practice carried out at school so that with good teaching practice it can improve the PK of prospective teachers properly (Irdalisa, 2021). The distance learning process applied should be in accordance with the 2013 curriculum, namely the application of scientific approaches, which are carried out through five steps of learning, namely observing, assessing, trying, reasoning, and communicating (Izzuddin, 2021). On the TK.B indicator, prospective teachers fit into the criteria well enough with a percentage of 74.06%. This is because people who want to teach biology still can't put together assessment tools based on how hard they are and how well they know their students, and the tools they use haven't been checked for validity and reliability.

https://doi.org/10.46627/silet.v4i1.191

PK results are also obtained from the RPP assessment sheet consisting of 5 components of assessment, namely: 1) there is an RPP identity; 2) indicators of competency achievement; 3) learning goals; 4) learning activities; and 5) assessment. The results of the data processing assessment of CK prospective biology teachers on distance learning based on observation sheets are presented in the figure 1.

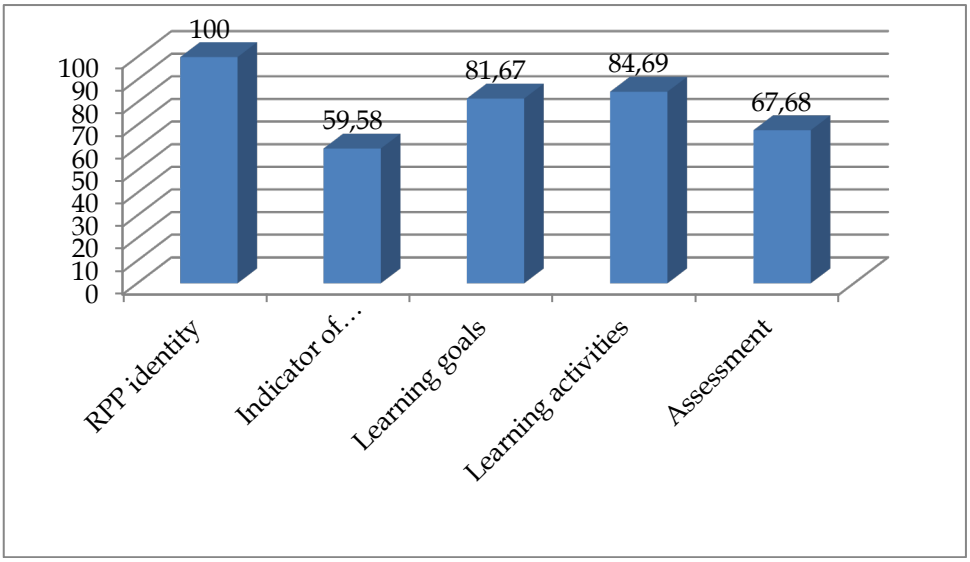


Figure 1. Average percentage on each RPP component

Based on Figure 1 above, it is known that the component that has the highest score is the RPP identity component (100%), indicating that all prospective teachers have listed the identity of RPP. The component that has the lowest score is the competency achievement indicator component (59.58%) due to the number of prospective teachers who do not include competency achievement indicators in the RPP that has been made. In mastering effective learning strategies prospective teachers are still low (Maryati et al., 2019). In addition, prospective biology teachers have not been able to identify students' prior knowledge, master learning theories related to approach strategies, methods, and models, and determine aspects of learning processes and outcomes that are important to be assessed and evaluated with the characteristics of the subjects they teach (Elvianasti, 2019). PK can be stimulated through various professional trainings, so that the training can help teachers to succeed in the learning process in the classroom (Kalsum, 2017). In addition, according Sæleset & Friedrichsen (2021), prospective teachers should also be encouraged to collaborate with each other to examine their pedagogical and content skills and a curriculum is needed that can equip prospective teachers in understanding basic knowledge and pedagogical principles (Al-Jaro et al., 2017).

Content Knowledge (CK)

Prospective teachers are not only equipped with content knowledge but also knowledge about teaching, students, and other instruments that support learning and learning evaluation (Elvianasti, 2019). Content Knowledge (CK) is the knowledge of the content or material that will be delivered in learning. A prospective biology teacher must have an in-depth knowledge of biological concepts so that learning can be conveyed properly and in accordance with learning goals. Prospective students who do not fully comprehend and master the material are unable to choose and determine how to teach it (Supriyadi et al., 2018). The ability of CK prospective biology teachers in distance learning is measured by video learning analysis and CK observation sheet consisting of 3 indicators, namely, 1) the breadth and depth of material; 2) material conformity; and 3) material development. The results of the data processing assessment of CK prospective biology teachers on distance learning based on observation sheets are presented in the following table.

https://doi.org/10.46627/silet.v4i1.191

Table 4. Technological Knowledge Assessment (PK)

No.	Prospective teachers	Indicator			Value (%)	Criteria
		CK.A	CK.B	CK.C		
1	MM1	24	9	15	75	C
2	MM2	24	9	15	75	C
3	MM3	31	11	16	90.63	A
4	MM4	31	12	20	98.44	A
5	MM5	24	11	15	78.13	B
6	MM6	24	9	15	75	C
7	MM7	28	10	18	87.5	A
8	MM8	31	11	18	93.75	A
9	MM9	30	12	18	93.75	A
10	MM10	28	11	16	85.94	B
11	MM11	24	9	15	75	C
12	MM12	22	10	11	67.19	C
13	MM13	28	10	15	82.81	B
14	MM14	25	10	14	76.56	B
15	MM15	22	9	15	71.88	C
16	MM16	25	9	15	76.56	B
17	MM17	22	9	14	70.31	C
18	MM18	29	10	16	85.94	B
19	MM19	25	9	15	76.56	B
20	MM20	27	9	17	82.81	B
	Total	524	199	313		
	Average (%)	81.88	82.92	78.52	80.94	B

Indicator Description: CK. A is Suitability and depth of material, CK. B is Material conformity and CK. C is Material development The ability of CK prospective biology teachers based on tables, in general, is on good criteria with a percentage of 80.94%. The result of the ability of CK prospective biology teachers is an ability that has the highest interpretation compared to the ability of TK and PK. This shows that prospective biology teachers already have a good mastery of the material and are able to convey it through distance learning.

In general, the indicator of breadth and depth of matter (CK. A), prospective teachers already understand the concept of the material taught and are able to convey it well systematically, logically, and clearly. However, some prospective teachers are still unable to convey material in the realm of concept analysis. On the CK.B indicator, prospective biology teachers are also able to adjust the material according to learning objectives, basic competencies, and characteristics of learners. This is in line with research (Elvianasti, 2018) that the CK of prospective teachers needs to be improved, especially in mastering biological concepts. However, on the CK.C indicator in the development of materials, the lack of prospective biology teachers is in the ability to associate biological matter with other materials in the IPA clump. This is in line with research (Malichatin, 2019), which states that prospective teachers are still less able to associate the material with other relevant materials.

CONCLUSION

Based on the results of the research and discussion that have been outlined, it can be concluded as follows: The ability of TK aspiring biology teachers in distance learning is based on good criteria so that the interpretation of prospective biology teachers already has mastery of ICT-based learning media and is able to make good use of it. The ability of PK prospective biology teachers in distance learning is based on good criteria so that the interpretation of prospective biology teachers has been able to implement and evaluate learning well and is able to design a learning plan in the form of an RPP. PK's ability of prospective biology teachers has the lowest interpretation among TK and CK skills, because there are still shortcomings in learning evaluation indicators and some components in RPP. The ability of CK prospective biology teachers in distance learning is based on good criteria so that in interpretation, the prospective biology teacher has mastered the breadth and depth of the material, is able to adjust the

material to the learning objectives and characteristics of learners, and is able to develop the material well.

From the results of the research, it can be recommended that there is a need for a program in developing the TPACK competence of prospective teachers so that they will be better prepared to face digital-based innovative learning.

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