



## **Tpack Capability Analysis Students of Biology Education Study Program on Animal Physiology Learning with Online Learning Models**

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<b>Article Info</b>	<b>Abstract</b>
<p>Article History : October 2022 Accepted January 2023 Published April 2023</p> <p>Keywords: TPACK, Online Learning, and Animal Physiology.</p>	<p>The aim of education in Indonesia is to educate the life of the nation. In an effort to realize the goals of Indonesian education, a teacher as an educator must understand and have Technological Pedagogical Content Knowledge (TPACK) skills, especially during the Covid 19 pandemic which requires learning to be done online. One of the subjects that develops TPACK abilities is Animal Physiology at the Department of Biology, Semarang State University. The purpose of this study: 1) Knowing the process of implementing Online Learning which is carried out in Animal Physiology lessons can improve the TPACK abilities of Biology Education study program students. 2) Knowing the TPACK ability level of Biology Education study program students after participating in Online Learning Animal Physiology. This research is a mixed method research with an explanatory sequential design. Selection of the sample by purposeful sampling. The research population is all students majoring in Biology class of 2019. The research sample is students of the Biology Education Study Program Classes B and C who are taking the Even Semester Animal Physiology course in the 2020/2021 academic year. The results showed that learning Animal Physiology online by using project assignments can foster TPACK abilities in Biology Education study program students. TPACK's capabilities can be seen and observed from the initial online learning meeting activities to the completion of project assignments.</p>

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## INTRODUCTION

One of the goals of national education in Indonesia is to educate the life of the nation. Refinement and development of the education curriculum in Indonesia is a concrete manifestation of achieving this goal. This is increasingly supported by the Industrial Revolution 4.0.

The Industrial Revolution 4.0 is a comprehensive transformation of all aspects of production in the industry through the merger of digital and internet technology with conventional industries (Merkel, 2014). The availability of information that is always connected by utilizing digital technology and the internet is one of the solutions to the problem when the Covid 19 pandemic outbreak emerged.

The emergence of this epidemic is a new challenge for the world of Indonesian education. Teachers as educators are required to provide more optimal teaching and education by utilizing developments in digital technology and the internet. Utilization of technological and information developments to provide assignments and materials online produces learning known as Online Learning.

The development of science and technology can be used as a way to improve the quality of learning conducted by a teacher. To be able to make this happen, a teacher needs to understand and have Technological Pedagogical Content Knowledge (TPACK) skills.

One way to improve teachers' TPACK skills is through training and development from an early

age. One of the subjects that develops TPACK abilities is Animal Physiology at the Department of Biology, Semarang State University. Learning Animal Physiology with a project-based learning method or better known as Project Based Learning (Pj-BL) requires students to master the material well, create and develop a research project by utilizing technological developments, and have the ability to present research results and information that has been obtained.

Therefore this research needs to be conducted to find out how the process of implementing Online Learning in learning Animal Physiology can help improve and develop the TPACK abilities of Biology Education study program students.

## METHOD

The research was conducted at the Department of Biology, Semarang State University from July 2021 to January 2022. This research was a mixed method study with an explanatory sequential design. The sample selection technique was carried out by purposive sampling.

The population in this study were all students majoring in Biology class of 2019. The sample in this study were students of the Biology Education study program B and C classes who were studying in the even semester of the 2020/2021 academic year.

In this study the method of data collection and the data needed is shown in table 1.

**Table 1.** Types, Methods, and Data Analysis Techniques.

Types of Data	Target	Metode	Instrument	Analysis Techniques
Main Data	a. TPACK ability of Non-Test Biology students	Non Test	Observation Sheet and Questionnaire	Analysis Descriptive
	b. Student responses regarding learning Animal Physiology through Online Learning	Non Test	Interview Sheet	Analysis Descriptive
	c. The process of implementing Animal Physiology learning through Online Learning	Non Test	Observation Sheet	Analysis Descriptive
Supporting Data	a. Results of the final assessment of the Animal Physiology project	Non Test	Product Assessment Sheet and Performance Assessment Sheet	Analysis Descriptive

Student responses are described using the Linkert Scale which is used to measure attitudes, opinions and perceptions of a person or group of

people about a particular phenomenon that you want to know about. In the Linkert Scale questionnaire/questionnaire used, 5 alternative

answers were provided, namely Strongly Agree (SS); Agree (S); Doubtful (RR); Disagree (TS); and Strongly Disagree (STS). For scoring answers to questions as follows; SS = 5, S = 4, RR = 3, TS = 2, and STS = 1 with the scoring rubric shown in Table 2.

**Table 2.** Guidelines for the Linkert Scale Scoring Rubric

No.	Category	Average	Percentage
1.	High	4.00 – 5.00	> 80
2.	Moderate	3.00 – 3.99	60 - 79
3.	Low	1.00 – 2.99	< 60

The ability of TPACK is known by processing data using the percentage formula as follows:

$$P = \frac{a}{b} \times 100\%$$

Information:

P = Percentage of TPACK ability

a = Total score acquisition

b = Maximum score of the question

Analysis of interview data and observation results was carried out in an analytical descriptive manner based on the results of interviews with students. Analysis related to product assessment reports (project results reports), and presentation assessment reports are carried out according to the rubric provided.

## RESULTS AND DISCUSSION

The results of the analysis of Animal Physiology Online Learning activities were obtained based on direct observation and filling out a questionnaire. Students are given a questionnaire related to the TPACK abilities that emerge and develop while participating in Animal Physiology lessons.

Direct observations were made when studying Animal Physiology online through the Zoom.us virtual meeting conference application.

The results of the observations are described in the description of student activities below:

### Animal Physiology Learning Activity Report

#### a. Technology Capabilities

Students can take advantage of the virtual meeting conference application (namely: Zoom.us) by using the facilities available in Zoom. Some of the facilities used are open video or microphone, share screen, raise hand, and room chat. Some students (komting) also use the record feature to record activities from the beginning to the end of learning. The student recording will process the video and send it back with the link address.

#### b. Pedagogic Ability

Students try to convey questions to the lecturer in language that is easy to understand. Students also show concrete examples when answering questions or expressing opinions so that other students can more easily understand and apply them.

Students begin to make self-regulation so that the discussion continues regularly in turn. Each student provides an opportunity for other students to submit questions, income, or respond to answers from other students.

#### c. Content Mastery Capability

Students respond to some interesting information regarding Excretion and Osmoregulation material, for example when responding to an increase in Earth's temperature can cause female sea turtle eggs to hatch. As a result, turtles will find it difficult to breed because the number of male turtles is decreasing. The worst thing that happened was the extinction of the sea turtles.

Students try to explain pictures of active and passive membrane transport processes according to the pictures pointed by the lecturer. Students also explain the concrete process of osmosis that occurs in erythrocytes causing erythrocytes to lyse.

Students explain according to their initial understanding with reinforced reference sources, both articles and videos. After students express their opinions, the lecturer provides reinforcement regarding active and passive membrane transport processes (diffusion and osmosis processes).

#### Animal Physiology Project Report

The results of the analysis of the Animal Physiology project report are obtained based on an assessment using an assessment rubric. Some of the aspects assessed in the report include: scientific quality, logical consistency of background, problem identification and problem formulation, currentness and relevance of reference literature,

research/observation methods, presentation of results, sharpness of discussion analysis, and accuracy of drawing conclusions. Analysis data of the Animal Physiology project report are presented in Tables 3 and 4..

**Table 3.** Project Proposal Title

No.	Proposal Title
1.	Effect of Lead Exposure on Sperm Production in White Rat ( <i>Rattus novergicus</i> ) Testicles
2.	Effect of Salinity on the Survival of Tilapia ( <i>Oreochromis niloticus</i> )
3.	Comparison of Breathability of Catfish ( <i>Clarias Batrachus</i> ) and Tilapia ( <i>Oreochromis Niloticus</i> ) by Measuring BOD Levels and Fish Behavior in Oxygen Poor Media
4.	Comparison of Diuretic Effects between Coffee and Carrot on Rat Urine Volume and pH
5.	Effect of Alcohol on Mice Motor Movement

6.	Effect of Lead on Rat Stomach Acid Levels
7.	The effect of the photoperiod on the ovaries of birds
8.	Analyzing Hemoglobin Levels, Number of Erythrocytes, and Leukocytes in Vertebrata Animals

Based on Table 3 it shows that there are various titles of research proposals as student final projects in learning Animal Physiology. Even though learning activities are carried out online, the project work process can be carried out in person by each project member.

The various titles of research project proposals show that lecturers are trying to cultivate students' critical and curious attitudes towards information. In addition, the use of various learning media, learning resources, and technology that supports the learning process, especially in completing project assignments, is expected to be able to grow and develop students' TPACK abilities.

**Table 4.** Analysis of Project Results Reports

No.	Assessment Aspects								Total score
	Scientific quality	Consistency of logical background	Identification and formulation of the problem	Sophistication and relevance of reference literature	Research methods/ observations	Presentation of results	Sharpness of discussion analysis	Accuracy in drawing conclusions	
1.	3	2	2	3	3	2	3	2	20
2.	2	2	2	2	3	2	2	2	17
3.	3	3	2	2	3	3	3	3	22
4.	2	2	2	2	3	3	3	3	20
5.	3	3	3	3	2	2	3	3	22
6.	2	3	2	2	3	3	3	3	21
7.	2	3	2	2	3	3	2	2	19
8.	2	2	2	2	2	2	2	2	16
Total score	19	20	17	18	22	20	21	20	

Based on Table 4 it shows that the project results reports show varying results. The cooperation of group members starting from the activities of preparing proposals (including when looking for reference sources and providing media for research) to the research process and reporting of research results influences the results of the final project report.

The accuracy in choosing and using research methods gets the highest score, namely 22. This shows that students have begun to be trained in using various types of methods to complete projects. Selection and use of the method is an important process because the method chosen will be used

during project implementation and determine the success of the project.

Identification and formulation of problems get the lowest score, namely 17. This shows that Biology students still need guidance to identify and formulate problems according to the project to be completed. Identification and formulation of problems is important because the final results and conclusions of the project must be able to answer the problems identified and formulated.

#### TPACK Ability of Biology Students

Data analysis of the questionnaire components related to Pedagogical Knowledge is presented in Table 5.

**Table 5.** Pedagogical Knowledge Questionnaire

No.	Component/Statement	Average
1.	I can use a variety of styles when presenting the final project of Animal Physiology in front of friends with different mastery of material.	3
2.	I can assess the ability of each group member when presenting the final project of Animal Physiology.	3
3.	I know how to assess the performance of each group member when completing the final project of Animal Physiology.	4
4.	I know how to assess the performance of each group member when presenting the final project of Animal Physiology.	4
Average		3,5
( <i>%</i> )		70

Based on the questionnaire, it is known that the average result is 3.5 with a percentage level of 70% indicating that the level of ability of Pedagogical Knowledge is moderate. The observed Pedagogical Knowledge ability is in accordance with Table 5 that students are quite capable of presenting project results with a fairly good style and mastery of the material. Students are able to assess the abilities of group members starting from their performance while carrying out, completing, to presenting the results of the Animal Physiology project.

These communication skills form the basis of Pedagogical Knowledge skills. Experience in discussing, managing, communicating, and providing assessments can in fact foster the ability of Pedagogical Knowledge in students. Other supporting research states that the overall Pedagogical Knowledge ability of prospective teachers includes the ability to adjust learning, communicate, and confirm information so as to minimize misconceptions among students (Rahmadi, 2019).

During the presentation, group members will practice class management so that students from other groups focus on listening to the project results from the presentation group. This is in accordance with the opinion of Schmidt, et al (2009) which states that Pedagogical Knowledge is a teaching process involving methods for managing classes,

providing assessments, developing lesson plans, and learning processes.

Data analysis of the questionnaire components related to Content Knowledge is presented in Table 6.

**Table 6.** Content Knowledge Questionnaire

No.	Component/Statement	Average
1.	I have sufficient knowledge to complete the final project of Animal Physiology.	5
2.	I have sufficient knowledge to answer questions given by the lecturer when presenting the results of the final project of Animal Physiology.	4
3.	I know the basic theories and concepts from Animal Physiology courses.	3
4.	I use various methods and strategies to develop my understanding of Animal Physiology courses.	4
5.	I'm looking for the latest research related to the final project of Animal Physiology that my group is working on.	3
Average		3,8
( <i>%</i> )		76

Based on the questionnaire it is known that the average result is 3.8 at a percentage level of 76%. The observed Content Knowledge ability is in accordance with Table 6 which shows that the Content Knowledge ability level is moderate. Students are quite capable of understanding theory and information related to learning Animal Physiology and completed project assignments.

The ability to understand information is very important for students who are candidates for Biology teachers. Information leads to knowledge or specificity of scientific disciplines (Suyamto et al., 2020). Prospective teachers' Content Knowledge skills should utilize a variety of information sources. Content Knowledge is knowledge about the subjects to be studied or taught (Schmidt, et al., 2009). Content knowledge leads to knowledge or specificity of disciplines or lessons.

Data analysis of the questionnaire components related to Technological Knowledge is presented in Table 7.

**Table 7.** Technological Knowledge Questionnaire

No.	Component/Statement	Average
1.	I use technology when completing my final project in Animal Physiology.	5
2.	Saya memanfaatkan I take advantage of technological developments to add information and references to learning resources for Animal Physiology courses.	5
3.	I took advantage of the opportunity to work on the final project of Animal Physiology with various technologies.	4
4.	I can understand the material in the Animal Physiology course even though it is done using the Online Learning model.	4
Average		4,5
(%)		90

Based on the questionnaire, it is known that the average result is 4.5 with a percentage level of 90% indicating that the level of Technological Knowledge is high. The observed Technological Knowledge ability is in accordance with Table 7 that students are able to utilize a variety of technologies while participating in learning and completing Animal Physiology projects.

The technology used by students can be seen, for example, when making presentation slides, taking documentation via video or photos, even when working on projects using laboratory equipment, for example when sampling mice/mouses, taking blood, making cages, observing blood cells using a microscope, and other activities.

This is in accordance with the results of research according to Surani (2019), which states that technology is a development that can be utilized as a source of learning and information that facilitates the learning process by education students as prospective teachers. In education, the implementation of technology as a learning medium, administrative tool, and learning resource. Technology can also be a measure of the level of concern and understanding of information and communication.

Questionnaire component analysis data related to Pedagogical Content Knowledge is presented in Table 8.

**Table 8.** Pedagogical Content Knowledge Questionnaire

No.	Component/Statement	Average
1.	I can choose an effective way to convey/present the results of the final project of Animal Physiology.	5
2.	I can develop the final project of Animal Physiology in order to get maximum results.	4
3.	I can evaluate the performance of each group member during the final project of Animal Physiology.	4
4.	I can explain important information from my group's final Animal Physiology project in a way that is easily understood by other group members.	4
5.	I can identify the difficulties experienced by other group members when understanding and provide appropriate feedback on the presentation results of my group's final Animal Physiology project.	3
Average		4
(%)		80

Based on the questionnaire, it is known that the average result is 4 with a percentage level of 80% indicating a high level of Pedagogical Content Knowledge ability. The Pedagogical Content Knowledge abilities observed are in accordance with Table 4.6 which shows that students are able to explain important information, develop project assignments in order to obtain maximum results, and choose the most effective way to present project results.

In the Pedagogical Content Knowledge ability, students practice to become problem solvers from the theme of the project assignments that must be completed. This is consistent with the results that know what approach is appropriate for the teaching process and know how content elements can be arranged for good learning (Mishra and Koehler, 2006).

Shulman (1986) states that effective teaching requires more than just separating material and pedagogy. This is in accordance with the results of research by Sukaesih, Ridlo, and Saptono (2017)

which shows that most students can adapt learning strategies to the concepts in the material to be taught.

Other supporting research states that Pedagogical Content Knowledge is not only influenced by academic abilities but also influenced by experience and professional training and pedagogical abilities (Maryono, 2016).

Questionnaire component analysis data related to Technological Pedagogical Knowledge is presented in Table 9.

**Table 9.** Technological Pedagogical Knowledge Questionnaire

No.	Component/Statement	Average
1.	I can choose technology that improves the results of the final project of Animal Physiology.	4
2.	I can choose technology that supports the presentation of the final project of Animal Physiology.	5
3.	I can adjust the use of technology when taking Animal Physiology courses with the Online Learning model.	5
Average		4,7
( $\%$ )		93

Based on the questionnaire, it is known that the average result is 4.7 with a percentage level of 93% which indicates that the level of Technological Pedagogical Knowledge is high. The observed Technological Pedagogical Knowledge ability is in accordance with Table 9 that students are able to choose the technology used to support and improve project outcomes. Students also adjust the type of technology used during Animal Physiology learning activities.

Various student knowledge of the application of technology in teaching is part of the Technological Pedagogical Knowledge ability. If every student has this ability it will have a big impact on teaching able to change the way teachers teach (Schmidt, et al. 2009).

Data analysis of the questionnaire components related to Technological Content Knowledge is presented in Table 10.

**Table 10.** Technological Content Knowledge Questionnaire

No.	Component/Statement	Average
1.	I can explain the technology used to help complete the final project of Animal Physiology.	5
2.	I know how to use technology to find sources of information and references in strengthening the results of the final project of Animal Physiology.	5
3.	I know how to use major/special technologies (Sonde technique, taking blood, or other special techniques) in completing the final project of Animal Physiology.	4
Average		4,7
( $\%$ )		93

Based on the questionnaire, it is known that the average result is 4.7 with a percentage level of 93% which indicates that the level of Technological Content Knowledge is high. Students are able to explain the technology used during learning and working on the final project. The technology used by students is not only modern technology, but also simple technology. Some simple technologies used by students, among others, when using a sonde and appropriate sonde techniques and a tool to take blood from rats/mice as test animals.

This is consistent with the results of research that Technological Content Knowledge (TCK) as knowledge about technology can create a new picture of certain materials (Schmidt, et al, 2000).

Data analysis of the questionnaire components related to Technological Pedagogical and Content Knowledge is presented in Table 11.

**Table 11.** Technological Pedagogical and Content Knowledge Questionnaire

No.	Component/Statement	Average
1.	I can use a strategy that combines content, technology, and style to present the final results of an Animal Physiology project.	5
2.	I can choose content-enhancing technologies to complete an Animal Physiology project to make it look interesting.	3
3.	I can choose the technology used when my group presents the final project of Animal Physiology, so that it can increase the understanding of other group members.	5
4.	I can provide information regarding the final outcome of an Animal Physiology project by combining research ideas, technology, and ways to properly complete the project.	4
Average		4,3
( $\%$ )		85

Based on the questionnaire it is known that the average result is 4.3 with a percentage level of

85% indicating that the level of TPACK ability is high. Students are able to use strategies to understand content/material, technology, and communicate to other groups through presentations of project results. During the learning process and completion of the Animal Physiology project, students also use technology to understand content/material so that they can communicate the content/material obtained to other students. This is in accordance with the results of Sa'adah and Kariadinata's research (2018) which found that the TPACK ability of prospective teachers was in the good category because prospective teachers could organize learning by integrating information technology and computers.

Technological Pedagogical and Content Knowledge (TPACK) is knowledge about the complex interaction of domain knowledge principles (technology, pedagogic, and content) (Mishra & Koehler, 2006).

Research on Technological Pedagogical Content Knowledge (TPACK) was conducted by Chai, Koh, & Tsai (2013). The research examined around 74 literature including journals and articles related to TPACK. The results of the study stated that teachers need TPACK for effective learning in the classroom. TPACK describes the various types of knowledge that teachers need to teach effectively with the help of technology and various complex procedures in the field of knowledge interaction.

## CONCLUSION

The conclusions of this study are:

1. Learning Animal Physiology with an online learning model that applies a final assignment in the form of a project can actually foster TPACK abilities in Biology Education study program students.
2. Visible and observable TPACK capabilities starting from the preparation of online learning activities to the completion of project assignments.

## SUGGESTION

Suggestions from this study include:

1. In carrying out project assignments, students should communicate more often with lecturers and laboratory assistants to minimize failures while working on projects.

2. It is necessary to procure tools and materials to support project tasks, especially tools and materials that are only provided in the Biology Laboratory.

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