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Students' Perceptions of The Effectiveness of the 5E Learning Cycle and Problem-Based Learning Based on TPACK in Writing Scientific Article

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ABSTRACT

Writing scientific papers is unavoidable for the scientific community in higher education. As part of the scientific community, students must master the knowledge and skills of writing scientific papers. However, the reality on the ground has not shown the expected reality. Many students do not have sufficient knowledge and skills to write scientific papers. Not a few students still have shallow knowledge and skills in terms of writing scientific papers. This study examined students' perceptions of using the TPACK-based 5E-PBL learning cycle model to improve their ability to write scientific papers. The subjects of this study were 189 second-semester students who had taken Indonesian language courses from the Faculty of Economics and the Faculty of Teacher Training at Asahan University. The research method used was a descriptive research design with a quantitative approach. The research data was obtained by distributing surveys and interviews to all samples using the Google Forms platform. Based on the results of the data analysis, there was a significant increase. Around 51 students got very good scores, and 65 were in a good category. Thus, the effectiveness of the TPACK-based 5E-PBL learning cycle model in terms of educators (lecturers) shows a very high category (56%). While the average score showed the highest score 41% in the very high category viewed from the students' sub-variable. In sum, students considered using the 5E-PBL learning cycle model based on TPACK for Indonesian language courses on scientific paper writing material positively impacted the learning process.

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1. INTRODUCTION

The skill of writing scientific papers is a means for students to familiarize themselves with developing critical, rational, and objective reasoning power. The skills of writing scientific papers can also be used to disseminate scientific information to the wider academic community (Suyono, Amaliah, Ariani, & Luciandika, 2016). The habit of writing scientific papers can help students expedite the completion of their study assignments in tertiary institutions (Walck-Shannon, Rowell, & Frey, 2021). Writing scientific papers can also support student learning success in university (Defazio, Jones,

Tennant, & Hook, 2010; Tierney & Stefani, 2013). Therefore, learning the skills of writing scientific papers in tertiary institutions must be managed properly to be able to encourage students to be independent in reasoning, able to see the interrelationships between concepts and material, able to communicate in writing, and able to solve problems being faced in terms of writing scientific papers (Alsaleh, 2020; Darling-hammond et al., 2019). In this regard, students must be trained to interact and negotiate well with their surroundings, given the opportunity to reflect on the learning process they are undergoing, and allowed to develop their learning strategies. Thus, students can develop their abilities and skills as well as possible.

However, effectiveness in learning is a measure related to the level of success of a learning process (Supardi, 2013). Learning can be effective if a lesson can be carried out by a predetermined time, achieve all the learning objectives that follow what has been expected, and allow students to learn easily and pleasantly (Kennedy, Hyland, & Ryan, 2014). In this case, writing scientific papers is an unavoidable activity for the scientific community in higher education. As part of the scientific community, students must master the knowledge and skills of writing scientific papers (Grech, 2017). Writing scientific papers for students can help with daily activities related to writing scientific papers, such as developing communication skills. (Lu et al., 2019), critical thinking, and analytical skills (Walsh, Jia, & Vernon, 2020). A student's academic success and completion of tertiary institutions can be aided by writing scientific papers with expertise. It is advantageous for other scientific activities, such as discussions, seminars, training, and workshops, to have proficiency in writing scientific papers (Aini, Handayani, Husna, & Lestari, 2020). This shows that writing scientific papers is important in the academic field.

Scientific work is a work of writing that contains conceptual thinking problems, observations, and research results that are arranged systematically, using the correct language, straightforward, effective, and can be objectively accounted for (Widodo, 2018). Scientific work is compiled based on certain systematics commonly used and guided by the systematics of writing scientific papers that apply to a particular institution (Rosdiyanti & Nurfidah, 2022). Scientific work must use the standard correct language, and straightforward and effective rules (Tullu, 2019). The goal is for scientific work to be easily understood by others without causing double meanings. The truth of scientific work must also be accountable objectively. It means that the truth of scientific work must be verifiable by anyone. It is also hoped that the compiled scientific work can contribute to relevant scientific fields so that they are more developed and beneficial to human life. Students can also use scientific articles to disseminate information obtained from the results of research conducted using a publication.

Scientific publications carried out by students must contain all or part of the research results in the final assignment written in scientific article format (Rusliana, 2022). This aims to strengthen students' critical thinking skills and develop information so that it can be read by the larger scientific community. In this regard, what students need to pay attention to in publishing is that writing scientific articles must comply with the format determined by the intended journal. In general, the scientific article format consists of (1) title, (2) author's name and affiliation, (3) keywords, (4) abstract, (5) introduction, (6) results and discussion, (7) conclusion, and (8) bibliography (Scholz, 2022). Thus, it can be inferred that this format needs to be of concern to students in writing scientific papers to get satisfactory results so that they can be published in accredited journals.

The reality on the field has not shown the expected reality. Many students do not have sufficient knowledge and skills to write scientific papers (Bulqiyah, Mahbub, & Nugraheni, 2021; Nandiyanto & Azizah, 2022; Sulaiman & Muhajir, 2019). It is due to the lack of knowledge and skills in writing scientific papers properly and adequately. There are several obstacles faced by students when writing scientific articles, which ultimately makes the student's writing less qualified. The quality of scientific articles is determined by several aspects, namely writing (Franco, Rice, Schuch, Dellagostin, Cenci, & Moher, 2021; Hasanuddin, Emzir, & Akhadiah, 2019), research topics (Adelia, Wahyuli, Imanda & Perdana, 2018), *literature and empirical data (Aisiah & Firza, 2018)*, paraphrased citations (Agathokleous, 2021; Chen, 2021; Hafiar, Setianti, Damayanti, Ruchiat, & Anisa, 2019), and bibliography (Goyal, Dua, Kedia, Misra, Santhanam, & Ravindran, 2020). Additionally, it can be challenging for students to locate

scientific articles that are pertinent to their research interests (Tang, Liu, & Qian, 2021). It is also predicted that the cause of the low learning achievement of students' scientific writing is teaching materials, syllabi, lesson plans, learning models, and learning evaluation tools that have been used so far that do not support the process of learning to write innovative and creative scientific papers, do not treat students as the focus of learning, and still conventional. The unavailability of teaching materials, syllabi, lesson plans, learning models, and evaluation tools for learning innovative scientific writing skills is believed to be the cause of students' common knowledge and skills in writing scientific papers.

The Indonesian language course is set as one of the general compulsory courses in the higher education curriculum set by the Director General of Higher Education in 2020. In the guidelines for implementing the course, students are expected to be able to produce research by writing scientific articles. Many activities have been carried out to improve students' ability to write scientific articles. The activities that are mostly carried out by researchers in Indonesia are only in the form of training and mentoring activities (Isnawati, Badriyah, & Titin, 2021; Pramiastuti, Rejeki, & Pratiwi, 2020; Susetyo, Basuki, & Noermanzah, 2020). So it can be concluded that no one has developed a model to improve the ability to write scientific articles. Based on this, a learning model is needed to improve the ability to write scientific articles so that they can support the established curriculum. The development of teaching materials, syllabi, lesson plans, learning models, and TPACK-based scientific writing skills learning evaluation tools has a strategic function in the learning process, namely as an innovator and motivator for students.

In this regard, researchers as lecturers in Indonesian language courses for several faculties, the TPACK-based 5E-PBL learning cycle model have been applied in writing scientific papers for students at the beginning of the semester. The problem-based learning model (PBL) is an effective approach to teaching students how to write scientific articles (An Nisa, 2018). PBL is a teaching technique that provides problems to bring out the stimulus and focus of students (Gallagher, 2015; Kwan, 2009). PBL is widely used in higher education because it can improve students' critical thinking (Hine, 2006). Students' critical thinking skills can also be improved by using the 5E learning cycle model (*Engagement, Exploration, Explanation, Extension, and Evaluation*)(Cahyarini, Rahayu, & Yahmin, 2016; Ramdani, Jufri, Gunawan, Fahrurrozi, & Yustiqvar, 2021). Combining PBL and the 5E learning cycle can increase self-efficacy, critical thinking, learning attitudes, and learning satisfaction (Jun, Lee, Park, Chang, & Kim, 2013). Learning the 5E learning cycle can also increase students' learning motivation (Putra, Nurkholifah, Subali, & Rusilowati, 2018). Combining the 5E learning cycle with technology can also increase students' interest in learning (T.-C. Liu, Peng, Wu, & Lin, 2009). Therefore, the 5E-PBL learning cycle model is feasible to be applied in writing scientific papers.

Based on these problems, it can be assumed that PBL can be combined with the 5E learning cycle to solve problems experienced by students in writing scientific articles. In addition to learning models, students also need a lot of reference materials when writing scientific articles. One of the needs of students when writing scientific articles is the need for supporting technology to facilitate the process of finding ideas based on references and writing techniques (Anjali & Istiqomah, 2020; Khairina, Perdana, Harahap, & Siambaton, 2020; Rahardja, Tiara, & Rosalinda, 2016). Furthermore, by developing a TPACK-based model it is suspected that it can solve the problem of writing scientific articles. This suspicion arises because TPACK prioritizes technology in understanding the discovery of new things that can be used as ideas in writing scientific articles. So students no longer have difficulty finding references. TPACK provides consistent training in integrating the required use of technology (H. Liu, Wang, & Koehler, 2019). TPACK can also bridge content knowledge, teaching practices, and adequate use of technology for learning effectiveness (Wang, 2019). It assumed that combining this 5E learning model and PBL based on TPACK is a combination that allows a positive effect on students' academic writing skills.

TPACK learning has also been proven to improve the quality of learning, both for educators and students at the junior high school, high school, and university levels (Chai, Jong, & Yan, 2020). The use of technology in teaching should not only be conceptual but can be applied directly (Tanak, 2020).

TPACK also serves to prepare the learning environment for complex interactions between technology, pedagogy, and material knowledge. To produce innovation and renovation of 21st-century teaching practices that are following the current era of Society 5.0 (Goradia, 2018). However, based on the results of other studies, deficiencies were found in the TPACK learning framework, namely that there were still educators and students who were not used to using technology (Fuada, Soepriyanto, & Susilaningsih, 2020). This makes researchers take the initiative to apply TPACK, which will guide every step of the use of technology in learning. The 5E learning cycle is thought to be used to overcome problems in TPACK learning. Combining the TPACK-based 5E-PBL learning cycle model is thought will make it easier for students to find creative ideas and solve technical and substance problems in writing scientific articles. Therefore, it is necessary to develop a TPACK-based 5E-PBL learning cycle model to improve scientific article writing skills.

Based on the results of research that has been carried out to improve proficiency in writing scientific articles, there has been no research that has developed a TPACK-based 5E-PBL learning cycle learning model. This is a very interesting study to produce a new learning model based on two models and one approach, which are combined into one learning model. The results of the combination of these models will produce a new syntax based on the technology at each stage of the designed model syntax. Because these problems require learning innovation by making the most of technology. Previously there had been researched related to TPACK learning and the 5E learning cycle (Mustafa, 2016), 5E learning cycles and PBL (Jun et al., 2013), TPACK and PBL (Kamid, Perdana, Chen, & Wulandari, 2021; Lase, 2022). However, no one has researched all three simultaneously and linked them to scientific articles. After implementing the TPACK-based 5E-PBL learning cycle model, the researchers were interested in knowing student perceptions in terms of learning and the student experience. In parallel with the aim of this study, the following research question will be answered :

1. What are the students' perceptions on the effectiveness of 5E Learning Cycle-based and PBL-based on TPACK in writing scientific articles in terms of learning outcomes?"
2. What are the student's perceptions on the effectiveness of 5E Learning Cycle based and PBL based on TPACK in writing scientific articles in terms of lecturers?
3. What are the students' perceptions on the effectiveness of 5E Learning Cycle-based and PBL-based on TPACK in writing scientific articles in terms of students' experience?

2. METHODS

The research method used was a descriptive research design with a quantitative approach. The research data was obtained by distributing surveys to all samples using the Google Forms platform after applying the TPACK-based 5E-PBL Learning Cycle. Thus, interviews were conducted to support the data. In this study, the population used was 226 students of the Faculty Teacher Training (KIP) and the Faculty of Economics class of 2022 at Asahan University and a sample of 189 students were selected. This study used purposive sampling. This study uses a measurement scale with a Likert Scale. Validity test using the Pearson Correlation method assisted by the SPSS 20 for Windows program. Respondents in the validity test of this instrument were taken from Asahan University Mechanical Engineering students class of 2023 outside the research sample with a total of 20 students and rtable values with a 5% significance level of 0.444. The instrument validity test obtained 24 valid items and 11 invalid items. Items with high validity totaled 7 items, 14 items of sufficient validity, 7 items of low validity, and 4 items of very low validity. The instrument reliability test in this study used the Cronbach Alpha method assisted by the SPSS 20 for Windows program. Invalid items are not included in the reliability test. Work readiness instrument reliability test with a total of 24 items. The coefficient of the Cronbach's Alpha value obtained is more than 0.6, it can be concluded that the work readiness instrument is reliable with a very high level of reliability. The data analysis technique in this study used quantitative analysis which was used to process data from a questionnaire that was distributed to a sample of students to determine the effectiveness of learning using TPACK-based 5E-PBL which has been used in Indonesian language courses on scientific paper writing material.

3. FINDINGS AND DISCUSSION

The following will describe the results of research on student perceptions of the TPACK-based 5E-PBL learning cycle model that has been applied to the specified variables.

3.1 The description of the effectiveness of the TPACK-based 5E-PBL learning cycle model data in terms of learning outcomes

To measure the success or otherwise of using the TPACK-based 5E-PBL learning cycle model, the results of assessments or different course activities are compared. The results of students' ability to write scientific articles were obtained by observing student performance when writing scientific articles using the TPACK-based 5E-PBL learning cycle. Implementation of group discussions in the TPACK-based 5E-PBL learning cycle emphasizes providing a process of self-learning experience for students to obtain information and solve problems with difficulties in using technology in writing scientific articles. The following data is obtained from lecturers who teach these courses and have applied the model to all sample classes.

Table 1 Data of Students' Scores in Writing Scientific Articles

Interval Scores	Categories	Total of Students	
		Before	After
80-100	Very Good	33	51
66-79	Good	31	65
56-65	Fair	56	38
40-55	Poor	49	24
0-39	Very Poor	20	11
Total		**189**	

Table 1 above shows that out of 189 students, only about 33 students were declared capable or in the very good category in writing scientific articles with a score interval of 80-100. From the data before and after it can be seen that the increase occurred when the TPACK-based 5E-PBL learning cycle model has been applied. After the implementation of the TPACK-based 5E-PBL learning cycle model there was a significant increase, around 51 students got very good scores, 65 in the good category, 38 in the medium category, 24 in the low category, and 11 people in the very low category. In its application in class, lecturers give certain problems to students, and in groups, they try to solve problems with certain solutions. In the learning process, lecturers teach students to use several applications that support the ease of writing articles, such as the Mendeley, Publish or Perish, and Quilbott applications. This shows that problem-based learning is more efficient and fosters student creativity when applied to learning. The average student learning outcomes improved as a result of problem-based learning (Rasyid, Ulya, Hayati, & Asmawati, 2023). The use of technology in the learning process will improve the quality of teaching and learning (Sahin & Yilmaz, 2019; Yates, Starkey, Egerton, & Flueggen, 2020). The data above shows that there is a significant increase in the ability of Asahan University students to write scientific papers. Using TPACK in writing scientific papers that are applied by lecturers can help develop learning tools for educators, while for students this can make the learning process easier and more efficient (Aniq, Drajati, & Fauziati, 2022; Sholihah, Yuliati, & Wartono, 2016). Thus, the TPACK-based 5E-PBL learning cycle model was successfully applied to improve the ability of Asahan University students to write scientific papers.

3.2 The description of the effectiveness data of the TPACK-based 5E-PBL learning cycle model in terms of educators (lecturers)

The results of the description of the data regarding the effectiveness of the TPACK-based 5E-PBL learning cycle model with educator (lecturer) sub-variables from respondents totaling 189 students are described in indicators which can be seen in Table 2.

Table 2 The effectiveness of the TPACK-based 5E-PBL learning cycle model is viewed from the lecturer's sub-variables in each learning indicator

No	Indicators	Criteria			
		Very High	High	Low	Very Low
1.	Preparation of Lesson Plan	53%	27%	20%	0%
2.	Learning Environment Preparation	22%	49%	19%	10%
3.	Implementation of the Lesson Plan	37%	57%	4%	2%
4.	Utilization of time in learning	29%	39%	26%	6%
5.	Teacher interaction with students	30%	52%	18%	0%
6.	Achievement of learning objectives	55%	41%	4%	0%
	Average	38%	44%	15%	3%

Adapted from (Prasetyo, 2016)

Based on Table 2, the highest average score was in the high category (44%). This data showed that lesson plan preparation and achievement of learning objectives were in the very high category, with percentages of 53% and 55%, respectively. Then the preparation of the learning environment also obtained a high percentage of 49% and followed by the implementation of the lesson plan the score was 57%. The preparation of the learning environment in each lesson will affect the effectiveness of learning. A conducive and comfortable atmosphere or environment is needed to support the learning process so that it runs effectively (Sani, 2013). But the preparation of the learning environment also gets the highest score for the very low category of 10%. This is due to the lack of sufficient devices or laptops for students in terms of the flexibility of student devices. With the interactions carried out by lecturers and students well established, the second highest percentage value was obtained at 52% after the implementation of the lesson plan. This shows that each aspect influences the other so that learning can run well and effectively.

Table 3 The effectiveness of the TPACK-based 5E-PBL learning cycle model is viewed from the lecturer's sub-variables in each indicator

No	Indicators	Criteria			
		Very High	High	Low	Very Low
1.	Lecturer physical readiness	60%	38%	2%	0%
2.	Preparation of learning devices	55%	30%	15%	0%
3.	Lecturer creativity	40%	47%	10%	3%
4.	Appropriateness of the technology used	66%	34%	0%	0%
5.	Mastery of materials	60%	27%	3%	0%
	Average	56%	35%	6%	1%

Based on Table 3, the average score of the effectiveness of the TPACK-based 5E-PBL learning cycle model in terms of educators (lecturers) shows a very high category (56%). The physical readiness of the lecturer in each meeting using this model can be said to be included in the very high or high criteria, both of which get the same percentage. This explains that the lecturer is physically ready to teach learning to write scientific papers with the TPACK-based 5E-PBL learning cycle model which is carried out in successive weeks, and learning carried out in successive weeks does not affect the lecturer's performance in teaching from the first week to the last week of the study. Preparation of learning tools in each meeting using this model is at a high criterion of 50%. This explains that lecturers always prepare learning tools for Indonesian language courses with the TPACK-based 5E-PBL learning cycle model. In the aspect of creativity, the lecturer is in the high category with a percentage of 47%, while in the aspect of the suitability of the technology used and mastery of the material is in the very high category with a percentage of 66% and 60%. It can be concluded that the overall score obtained is in the very high category.

3.3 The description of the data on the effectiveness of the TPACK-based 5E-PBL learning cycle model in terms of students

In the learning process, perceptions have a big role. Perception refers to the process of interpreting the messages or information of our senses to get the meaning of the environment. Through human perception, it is constantly in contact with the environment (Johns & Saks, 2020). Perception is one of the factors which influences a person's success in learning (Kleinke, 1978). When the students have a good perception of the project or assignment which is given by the lecturer, it can lead students to be successful in learning. On the contrary, if the students have a bad perception, it leads them to fail in learning, and it will be difficult for them to find their interest in learning (Pratiwi & Triprihatmini, 2018). Thus, The results of the data description regarding the effectiveness of the TPACK-based 5E-PBL learning cycle model with student sub-variables from respondents can be described in indicators that can be seen in Table 4.

Table 4 The effectiveness of the TPACK-based 5E-PBL learning cycle model is viewed from the student sub-variables in each indicator

No	Indicators	Criteria			
		Very High	High	Low	Very Low
1.	Student physical readiness	25%	38%	25%	12%
2.	Motivation	37%	53%	8%	2%
3.	Interest and concern	16%	32%	24%	16%
4.	Student attendance rate	68%	28%	4%	0%
5.	Mastery of materials	60%	30%	8%%	2%
6.	Saturation and fatigue	22%	39%	29%	10%
	Average	41%	36%	15%	6%

From Table 4, the average score showed the highest score 41% in the very high category. The results show that the level of student attendance is in the highest category, with a score of 68%, followed by mastery of the material, which is as much as 60%. This shows that the higher the level of student attendance, the greater the influence on student learning outcomes (Sari, 2020; Yudiawan, 2019). While aspects that are in the high category are motivation as much as 53% and saturation and fatigue as much as 39%. This is important considering that learning motivation is very much needed in learning (Deswarni, 2016). However, saturation and fatigue also have a high percentage for the low category, as much as 29%, and higher than other aspects. Meanwhile, the lowest aspect is found in the physical readiness of students as much as 12% and is higher than other aspects. This is because students feel insecure, which causes them to seem not physically ready to learn with the TPACK-based 5E-PBL learning cycle model. Then in the aspect of student attendance, none of the students felt lazy or avoided class meetings and it can be seen from the aspect of mastery of the material with a very low perception of 2%, which means students understand the material well.

In addition, from the results of the interviews, several students argued that applying the TPACK-based 5E-PBL learning cycle model was helpful when writing scientific articles. This statement was made by students who are willing to be resource persons as follows.

> *In my opinion, writing scientific papers makes learning more technology-based and I think that's cool, it's easier for me to find references from accredited journals according to my wishes through the Publish or Perish application. (Student 3)*
> *I feel that being taught by the lecturer using the technology-based 5E-PBL model, helps me I can easily get references for background writing from the Connected-paper application that was introduced by my lecturer in the Indonesian language course. (Student 7)*
> *After the lecturer introduced several applications that were foreign to me, I felt happy because it made it easier for me to write, even though I had to pay attention slowly. (Student 9)*

From the results of the interviews above, it can be explained that students feel that using this learning cycle model has a positive effect on them, starting from getting to know applications that they have never used and their interest in learning has also increased. Furthermore, the material for writing scientific papers is well-designed and clearly defined. Then the researcher asked whether after applying the TPACK-based 5E-PBL learning cycle model, it was possible to achieve the learning objectives. Following are the responses from some students.

In my opinion, applying the TPACK-based 5E-PBL learning cycle model, allows the learning objectives to be achieved more efficiently. It makes it easier for me to write down references and helps me to paraphrase difficult sentences by using the Quilbott app. And I feel my writing skills are getting better than before. (Student 2)

The learning cycle model applied by my lecturers helped me get good grades even though I previously felt that I did not understand enough to do scientific work. I also become more independent in doing my writing assignments from anywhere without having to only source from the library (Student 11)

Thus, the results of the interviews above support the results of the perceptions and learning outcomes they have obtained. So it can be concluded that based on the student's perception toward the TPACK-based 5E-PBL learning cycle model, using the TPACK-based 5E-PBL learning cycle model can be said to be meaningful learning and may improve the student's ability in writing scientific paper skills. It meant that the students have a positive perception of the use of the TPACK-based 5E-PBL learning cycle model.

4. CONCLUSION

Comparisons with the prior class will determine the efficacy of the TPACK-based 5E-PBL learning cycle model on learning outcomes and student views. After implementing the TPACK-based 5E-PBL learning cycle model, 51 students scored very well, 65 good, 38 medium, 24 low, and 11 extremely low. Lecturers rate the TPACK-based 5E-PBL learning cycle model as extremely successful (56%). The students' sub-variable had the highest average score of 41% in very high. Performance is determined by the number of students who pass the Indonesian language course in their first year and by their marks on final exams and other TPACK-based class assignments. Teachers employ the 5E-PBL learning cycle paradigm. This figure is compared to student results without this learning paradigm. The TPACK-based 5E-PBL learning cycle model yielded better outcomes. More than 25% more pupils passed the subject for the first time in the same year. Students in 5E-PBL scored much higher on the final exam than in typical settings. Students generally like this class's 5E-PBL. Most students find class 5E-PBL lessons beneficial or extremely effective for achieving learning goals and engaging them in technology-based topic content. They also said this activity was student-focused. Student consensus is that the 5E-PBL learning paradigm based on the TPACK cycle allows them to work autonomously and independently, especially when researching trustworthy publications. We found promising trends in learning outcomes and students' perceptions of the Class 5E-PBL methodology, but this study should be considered preliminary and supplemented by more course data and professor and faculty input. Students' interaction and involvement caused by technology in learning need more research.

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