EEAJ 13 (3) (2024) 231-244

Economic Education Analysis Journal
SINTA 3 Accredited
https://journal.unnes.ac.id/sju/index.php/eeaj

The Effect of Problem-Based Learning and Discovery Learning Models on Student Learning Outcomes Based on Teacher's TPACK

Tya Wahyu Nofitri✉, **Dini Octoria**

DOI: 10.15294/eeaj.v13i3.11094

Economic Education Study Program, Faculty of Teacher Training and Education, Sebelas Maret University, Surakarta, Indonesia

Article History

Received: 03 August 2024
Approved: 02 October 2024
Published: 30 October 2024

Keywords

Discovery Learning; Economics Subject; Learning Outcomes; Problem-Based Learning; Technological Pedagogical Content Knowledge

Abstract

Learning outcomes are a reflection of students' understanding of the material delivered by the teacher. Teachers' success in teaching can be measured from the learning outcomes achieved by students. This study aims to determine the effect of the problem-based learning model, discovery learning, and Technological Pedagogical Content Knowledge (TPACK) of teachers on the learning outcomes of grade X students in Economics subjects. This research is quantitative research with an experimental method. The sample in this study were students of class X.E-9 and X.E-10 SMA Negeri 2 Surakarta in the academic year 2023/2024 who were taken by purposive sampling technique with the provision of the class with the lowest average score in economics. The data collection technique used observation for the learning model, tests to measure student learning outcomes, and questionnaires to measure teachers' TPACK levels. Research data analysis techniques used were descriptive statistical analysis and Anova Two-way. The results show that the problem-based learning model, discovery learning, and teacher TPACK level have been proven to affect student learning outcomes in Economics subjects. The problem-based learning model proved to be better when compared to the discovery learning model, because the average score of Economics learning outcomes of students taught using the problem-based learning model was higher than the average score of Economics learning outcomes of students taught using the discovery learning model. However, both learning models are equally good when combined with high teacher TPACK levels. Because, students with high teacher TPACK get better learning outcomes compared to students with medium and low teacher TPACK.

How to Cite

Nofitri, T.W., & Octoria, D.(2024). The Effect of Problem-Based Learning and Discovery Learning Models on Student Learning Outcomes Based on Teacher's TPACK. *Economic Education Analysis Journal*, 13 (3), 231-244.

✉ Correspondance Address:
Jl. Ir Sutami 36 A Kentingan Surakarta Indonesia, 57126
Email: tyawahyunofitri@gmail.com

p-ISSN 2252-6544
e-ISSN 2502-356X

INTRODUCTION

One of the efforts to build and improve the quality of human resources is through education. This is due to the fact that education is a fundamental thing for every individual that cannot be ignored. The learning activities will be able to run effectively and efficiently when education is carried out in a planned and systematic manner in order to achieve educational goals (Kaban, et al., 2021). Besides, learning is a collaboration between teachers, students, and learning resources. A learning can be considered successful when the objectives of the learning have been achieved. Therefore, in order to achieve the learning objectives, it is required to organise the learning process properly to make it fun, purposeful, and enjoyable. The learning model is one of the tools that can be used by teachers to organize the learning process (Ardianti et al., 2021).

In addition, the learning process is crucial in the world of education. In this case, teachers must pay attention in choosing the model or method that will be used in the learning process in the classroom. It also considers the characteristics of students, the material, facilities, and infrastructure, and the teacher's ability to apply the learning model or method used. The selection of learning models needs to be in line with the subject matter since there are occasions when different materials need to be delivered in different ways. The characteristics of students who are less capable of thinking and still have a simple mindset so that they need to be guided gradually to improve their thinking skills can affect the selection of learning models or methods (Suindhia, 2023).

In the planning stage, the teachers plan lessons by analyzing learning outcomes or gradually adapting students' learning outcomes. This is done to measure the ability of learners to achieve the learning objectives that have been set. Learning objectives are prepared based on the needs and characteristics of learners in the educational environment, not only on individual teacher preferences (Aminah & Sya'bani, 2023). Through planning, learning activities are expected to be more directed and by predetermined goals. Learning implementation includes material delivery activities using certain methods or strategies, and media so that learning can run effectively. Meanwhile, assessment in learning activities is carried out to monitor whether the learning methods used are effective (Kaban et al., 2021).

In the 21st century, teachers are required not only to have knowledge about the material being taught and how to teach it but also to have knowledge about technology and its use in learning and teaching due to the development of science, technology, and art in the field of education. In order to facilitate learning activities and improve learning outcomes, teachers must also have skills and knowledge in using various technological devices (Rahmadi, 2019). Pedagogical Knowledge of teachers in classroom management skills supported by clear and interesting learning methods can strengthen the relationship between teachers and students. Thus, teachers not only convey material but can also improve the quality of student learning (Octoria et al., 2023).

Other than teachers, students are also required to be independent in acquiring knowledge in formal or non-formal education. In accordance with the concept of an independent curriculum that integrates knowledge skills, literacy, skills, attitudes, and mastery of technology. Kurikulum Merdeka is the formation of independence in thinking determined by the teacher. In this case, the teacher is the main milestone in supporting success in education. During the current digitization era, the quality of education is influenced by technological developments because every activity carried out by teachers or students cannot be separated from digital-based devices (Nasution, et al., 2023).

Kurikulum Merdeka emphasizes the importance of combining learning with assessment, especially formative assessment, as a learning cycle. The principle of learning and assessment indicates the importance of developing learning strategies according to students' learning outcomes. The learning

process is carried out by providing varied subject matter and adjusting to students' understanding (Muthoharoh, 2023). SMA Negeri 2 Surakarta has implemented the Kurikulum Merdeka for class X and class XI, but class XII still uses the 2013 curriculum. As a result, the learning process for grade X and grade XI must be carried out by providing a variety of subject matter that is suitable for students' understanding. Nevertheless, based on the observation at SMA Negeri 2 Surakarta, from 3 October 2023 to 14 November 2023, the subject matter used by the teacher is not yet adapted to the learners' understanding.

It was found that the learning motivation of Class X students was still considered low, as evidenced by the fact that during teaching and learning activities, students were still playing on mobile phones and chatting with friends, and some even fell asleep when the teacher explained the material in front of the class. This is because the teacher still dominates the learning process, with the teacher explaining the material using the lecture method. The learning model used by the teacher needs to be more innovative and still uses a teacher-centered learning model. In addition, students' responses still need to improve, as evidenced by not asking questions when they do not understand the subject matter being explained by the teacher.

Table 1 presented the results of preliminary research which shows that the average results of the odd semester end assessment of class X SMA Negeri 2 Surakarta students in Economics subjects are still low. As evidenced by the total of 360 students who take Economics subjects, the average value of the odd semester final assessment is 76.91. In fact, there are two classes whose average score is below the KKM (75), namely class X.E-9 at 66.75 and class X.E-10 at 68.4. This finding is consistent with research conducted by Wungguli & Yahya (2020) stated that the low ability of students is caused by several factors, including students' interest in the material being taught is still lacking, the students are still difficult in understanding abstract material, and the teacher is not optimal in presenting the material into learning media. Furthermore, Fransiska & Ain (2022) argued that when learning activities take place, teachers are only guided by teacher books and student books that have been provided by the government. They also only use lecture and question and answer methods while ignoring the importance of using learning models during the learning process.

Table 1. The Average Score of Class X SMA Negeri 2 Surakarta

Class	Average Score
X.E-1	79.41
X.E-2	78.25
X.E-3	78.42
X.E-4	77.94
X.E-5	84.61
X.E-6	81.92
X.E-7	77.56
X.E-8	75.84
X.E-9	66.75
X.E-10	68.40

Source: Pre-research results at SMA Negeri 2 Surakarta

Muthik, et al., (2022) have reported that students' learning outcomes are not only influenced by the students but also by the way teachers teach during teaching and learning activities. Dakhi (2020) claims that improving student learning outcomes is determined by teacher competence. The teacher's ability to understand students, master learning materials, be communicative in delivering learning materials, and have a good personality will improve student learning outcomes.

Besides, teachers must be able to master the material to be taught so that they can choose learning strategies and can be adapted to the technology used. In order to implement learning, teachers are required to master technology, content knowledge, and pedagogy. The three pieces of knowledge interact, forming technological pedagogical and content knowledge (TPACK) (Koehler et al.,

2009). Yurinda & Widyasari (2022) stated that in accordance with the quality of education in Indonesia, teachers should be proficient in technology in learning in order to create a satisfactory learning process and results. Amelia et al. (2023) argue that the proficiency of each teacher is not only viewed from technology but also must develop pedagogic abilities and material content in learning. Thus, teachers' mastery of Technological Pedagogical and Content Knowledge (TPACK) can improve student learning outcomes. In addition, teachers need to be able to choose a suitable learning model for students. In selecting a learning model, teachers must consider the conditions or circumstances of students, learning materials, and learning resources to apply the learning model effectively and support the success of students' learning (Sinabariba, 2017). Muzana et al. (2021) also stated that applying the suitable learning model plays a role in improving learning objectives and motivating students. Choosing an appropriate learning model can improve student learning outcomes.

A learning model is a framework of activities that can systematically describe the implementation of learning and help teachers and students achieve their learning goals (Ardianti et al., 2021). Problem-based learning and discovery learning are both learning models that teachers can use to improve students' learning outcomes. Tania, et al., (2020) state that using the problem-based learning model can stimulate students to learn and think critically, improving their learning outcomes. In addition, the problem-based learning model is relevant in the 21st century because students must be more active and learn independently to understand problems. Problem-based learning is also suitable for integrating learning media in the form of technology because the use of technology can be one of the opportunities and challenges for teachers in building meaningful and enjoyable learning.

Pattiasina & Sopacua (2022) also claimed that the problem-based learning model can increase students' learning activeness and practical cooperation with friends and teachers so that the classroom atmosphere becomes more conducive to learning. In the same way, Bulotio et al.'s research (2020) states that using the problem-based learning model increases the average score of students. It can be seen in the test results of the experimental method using the problem-based learning model that the value is greater than that of the class that only uses the experimental method. Then, Janah et al.'s (2018) research also proves that the achievement of student learning outcomes in experimental classes using problem-based learning models is better than in control classes.

The results of Puspitasari & Nurhayati's research (2019) showed that using the discovery learning model affects the final ability of students with a difference of 42.3% higher than using conventional methods. Then the results of Dahlan's research, et al., (2023) show that student learning outcomes are higher than conventional learning. However, research conducted by Wabula et al., (2020) shows that there are differences between the use of problem-based learning models and discovery learning models. The class taught using the discovery learning model had an average value of 73.50, while the average value of the class using the problem-based learning model was 82.02. It indicates the difference in the effect of learning models on students' learning outcomes. The difference is seen from the characteristics of the two learning models in constructing students' cognitive. The discovery learning model emphasizes problems and discoveries, but students do not involve the teacher to do discovery planning. Whereas the planning stage is very important for learners in reviewing literature and organizing the investigation stage. Meanwhile, the problem-based learning model also emphasizes the introduction to the problem and the investigation of the problem that learners already know from the beginning of the meeting; learners are also active in planning the investigation together with their groupmates.

This study is expected to prove that the problem-based learning model, discovery learning, and teacher TPACK level affect student learning outcomes in Economics subjects The results of this study can be used as reference for teachers and prospective teachers to improve the quality of the learning process. In Economics subjects, the problem-based learning and discovery learning models as well as the teacher's TPACK level provide different influences on students' Economics learning outcomes. Based on the description mentioned earlier, it is deemed necessary to conduct a study with the title "The Effect of Problem-Based Learning and Discovery Learning Models on Student Learning Outcomes Based on Teacher's TPACK".

METHODS

This research is quantitative research with experimental method. The design of this research uses factorial design 3 x 2. Factorial analysis is applied by using a perfectly random design with a format of 3 rows and 2 columns or 3x2. This study aimed to determine the effect of two variables, namely learning models and teachers' TPACK level on Economic learning outcomes. Learning models were manipulated into problem-based learning and discovery learning, while teachers' TPACK levels were manipulated into high, medium, and low as illustrated in the Table 2.

Table 2. 3x2 Factorial Design: Impact of Learning Model and Teachers' TPACK Level

	Learning Model (A)	
Teachers' TPACK Level (B)	Problem Based Learning (A_1)	Discovery Learning (A_2)
High (B1)	$A_1 B_1$	$A_2 B_1$
Medium (B2)	$A_1 B_2$	$A_2 B_2$
Low (B3)	$A_1 B_3$	$A_2 B_3$

Source: Budiyono (2016)
Notes:
A : Learning Model
A1 : Problem based learning model
A2 : Discovery learning model
B : Teachers' TPACK level
B1 : High teacher TPACK level
B 2 : Medium teacher TPACK level
B3 : Low teacher TPACK level
A1 B1: Group taught with problem based learning model with high teacher TPACK level
A1 B2: Group taught with problem based learning model with medium teacher TPACK level
A1 B3: Group taught with problem based learning model with low teacher TPACK level
A2 B1: Group taught with discovery learning model with high teacher TPACK level
A2 B2: Group taught with discovery learning model with medium teacher TPACK level
A2 B3: Group taught with discovery learning model with low teacher TPACK level

RESULTS AND DISCUSSION

The population under study was students of grade X, SMA Negeri 2 Surakarta, with 360 students. The sampling technique used nonprobability sampling with purposive sampling. Sampling was determined by selecting two classes, X.E-1 and X.E-10, with the lowest average scores. As a result, X.E-9 and X.E-10 classes, with 36 students in each class, were selected as the research sample. The two samples were tested for equality using a t-test, and the result was that class X.E-9 and class X.E-10 had the same ability in economics. The method of collecting data on learning models by observation, learning outcomes measured using tests, and teachers' TPACK using questionnaires. This research uses the descriptive analysis method and Anova Two Way. Before conducting Anova Two Way, a prerequisite test consisting of normality test and homogeneity test was performed. In addition, the prerequisite tests in this study were the normality test and the homogeneity test. The normality test used the Anderson Darling test, and the homogeneity test used the Leve-

ne test, which was performed with the help of Minitab software.

Data collection in this study uses observations, tests, and questionnaires. Observation is carried out during the learning process to collect data related to student behavior. So that they can find out the advantages and disadvantages when implementing problem based learning and discovey learning models. To assess student behavior, this study will use an assessment rubric containing performance criteria to be used in assessing the quality of student performance during the learning process. The test will be used to find out the learning outcomes of students in Economics so that they will find out their ability and understanding after taking Economics lessons. The test in this study will use a written test in the form of multiple choice and description. The test in written form will be arranged based on a grid which includes learning indicators.

Then this study uses a questionnaire containing questions asked to respondents to find out the level of TPACK owned by teachers. The teacher's TPACK level questionnaire contains Content Knowledge (CK), Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Technological Pedagogical and Content Knowledge (TPACK). The classification of teachers' TPACK levels was divided into high, medium, and low using One-Sample T-Test assisted by SPSS software. With the interval formula as follows

$\mu - t_{((\alpha/2,n-1))} (s\sqrt{n}) \leq X \leq \mu + t_{((\alpha/2,n-1))} (s\sqrt{n})$

(Azwar, 2012)

μ =Mean

$t_{((a/2,n-1))}$ =Price t at a/2 and degrees of freedom n-1

s = Standard deviation of the score

n = Number of Subjects

The classification of teachers' TPACK levels is differentiated between the experimental class and the control class.

Thus, the categorization norms based on the X scale score in the control class and the experimental class are obtained as follows:

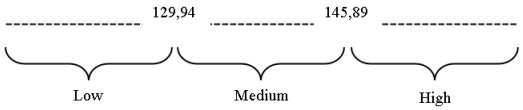

Figure 1. Categorization of Teacher TPACK Levels in Control Classes

X < 129.94	Low category
129.97 ≤ X ≤ 145.89	Medium category
145.89 < X	High category

Figure 1 shows that all subjects whose scores are below that interval (X less than 129.94) are categorized as having low TPACK Levels. Then all subjects whose scores are between 129.94 to 145.89 are categorized as having a medium TPACK level. And all subjects

Tabel 3. Result of Uji One-Sample T-Test Questionnare TPACK

One-Sample Test									
								95% Confidence Interval of the Difference	
	N	Mean	Std.Dev	Std. Error Mean	t	df	Sig. (2.tailed)	Lower	Upper
Control Class	35	137.91	23.221	3.925	35.13	34	0.000	129.94	145.89
Experimental Class	36	140.69	31.691	5.282	26.63	35	0.000	129.97	151.42

Source: Processed Primary Data, 2024

whose scores were above that interval (X greater than 145.89) were categorized as having a high TPACK Level.

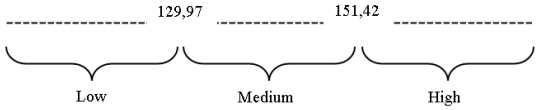

Figure 2. Categorization of Teacher TPACK Levels in Experimental Classes

$X < 129.97$	Low category
$129.97 \leq X \leq 151.42$	Medium category
$151.42 < X$	High category

Figure 2 shows that all subjects whose scores are below that interval (X less than 129.97) are categorized as having low TPACK Levels. Then all subjects whose scores are between 129.97 to 151.42 are categorized as having a medium TPACK level. And all subjects whose scores were above that interval (X over 151.42) were categorized as having a high TPACK Level.

RESULTS AND DISCUSSION

The data of this study, collected with strict objectivity, are in the form of students' economic learning outcomes and teachers' Technological Pedagogical and Content Knowledge (TPACK) scores based on students' perspectives. The first research data is the students' economic learning outcomes obtained from class X.E-9 and class X.E-10 SMA Negeri 2 Surakarta. The class X.E-9 is a class taught using problem-based learning model, while class X.E-10 is a class taught using discovery learning model. The second research data is the Technological Pedagogical and Content Knowledge (TPACK) score of teachers obtained from the same class, namely class X.E-9 and class X.E-10 SMA Negeri 2 Surakarta.

Teachers' Technological Pedagogical and Content Knowledge (TPACK) scores are classified into three levels, namely high, medium, and low levels of teacher TPACK, classifying teacher TPACK scores based on the scores obtained from each student against the mean and standard error of the mean of the teacher TPACK score from each class as well as with the t-table. The results of these calculations determined the lower-limit and upper-limit intervals of the high, medium, and low teacher TPACK categories. The intervals are the score intervals classified as the Middle category or the medium category in this study. Scores more significant than the upper limit of the interval will be interpreted as High, while scores smaller than the lower limit of the interval are categorized as Low.

Table 4. Students' Economic Learning Outcomes

	Problem Based Learning	Discovery Learning
High Teacher TPACK	87.78	83.64
Medium Teacher TPACK	78.30	77.20
Low Teacher TPACK	75.13	71.25

Source: Processed Primary Data, 2024

Table 4 shows that the average economic learning outcomes of students in classes taught using problem-based learning models with high teacher TPACK get a better average score than those taught using discovery learning models with high teacher TPACK. Then, the average economic learning outcomes of students in classes taught using problem-based learning models with medium teacher TPACK also get a better average score than classes taught using discovery learning models with medium teacher TPACK. The average economic learning outcomes of students in classes taught using problem-based learning models with low teacher TPACK also get a better average score than classes taught using discovery learning models with low teacher TPACK.

The results of the normality test in this study show that the p-value is 0.217 and then compared with α of 0.05. The result of this normality test is Ho is accepted because the p-value> α (0.217> 0.05). It can be concluded

that the samples in this study are normally distributed and can be continued with the homogeneity test.

Table 5. Normality Test Results of Economic Learning Outcomes Data

	Mean	St.Dev	N	AD	P-Value
Learning Outcomes	79.73	7.403	71	0.488	0.217

Source: Processed Primary Data, 2024

Table 6. Homogeneity Test Results of Economic Learning Outcomes

Method	Test Statistic	P-Value
Multiple comparisons	-	0.746
Levene	0.13	0.715

Source: Processed Primary Data, 2024

The results of the homogeneity test in this study show that the p-value is 0.715 compared with α of 0.05. In this homogeneity test, Ho is accepted because the p-value> α (0.715> 0.05). It can be concluded that the sample variance in this study is homogeneous. It indicates that the sample variance has a similar or identical nature, with similar characteristics and abilities. It is supported by the same measuring instrument used for the learning outcomes test, as well as the same instructors or teachers who teach in the control and experimental classes. By referring to the description of the prerequisite test, it can be concluded that the sample comes from a normally distributed population, and the variance of this study is homogeneous. Therefore, it is eligible to analyze the research data using Anova Two-Way. The hypothesis of this study was tested using the Anova Two-Way Technique (with a 3x2 factorial design). The results of the two-way variance analysis using Minitab software are presented in Table 6.

Hypothesis one tested in this study is "there is a difference in the effect of using problem-based learning and discovery learning models on the learning outcomes of grade X students in Economics subjects". Based on the results of the Anova Two Way calculation, the Fcount value is 8.11. Then these results were consulted with Ftable at the 5% significance level, with V1 = 1 and V2 = 70, so that Ftable was obtained at 3.98. In this research, hypothesis one test Ho is rejected and Hi is accepted because Fcount> Ftable (8.11> 3.98). Therefore, it can be concluded that there is a difference in the effect of using problem-based learning and discovery learning models on the learning outcomes of grade X students in Economics subjects. Then it was strengthened by the p-value results from the Anova Two Way analysis results, namely the p-value compared to the significance level of 0.05. The results of the Anova Two Way calculation obtained a p-value of 0.006 (<0.05), therefore it can be concluded that Ho is rejected and Hi is accepted because the p-value < the significance level (0.006 <0.05) which means that there is

Table 7. Results of Hypothesis Testing: Impact of Learning Model and Teachers' TPACK on Student Outcomes

Source	df	Adj SS	Adj MS	F-*Value*	P-*Value*
Learning Model	1	135.06	135.06	8.11	0.006
Teacher TPACK	2	2084.41	1042.21	62.55	0.000
Learning Model*TPACK Teacher	2	23.06	11.53	0.69	0.504
Error	65	1083.10	16.66		
Total	70	3835.92			

Source: Processed Primary Data, 2024

a difference in the effect of using the problem-based learning model and discovery learning on the learning outcomes of class X students in Economics subjects.

Hypothesis two tested in this study is "there is a difference between the level of Technological Pedagogical Content Knowledge (TPACK) of high, medium, and low teachers on the learning outcomes of grade X students in Economics subjects". Based on the results of the Anova Two Way calculation, the Fcount value is 62.55. Then these results were consulted with Ftable at the 5% significance level, with V1 = 1 and V2 = 70, so that Ftable was obtained at 3.98. In this research, hypothesis one test Ho is rejected and Hi is accepted because Fcount> Ftable (62.55> 3.98). Therefore, it can be concluded that there is a difference between the level of Technological Pedagogical Content Knowledge (TPACK) of high, medium, and low teachers on the learning outcomes of grade X students in Economics subjects. Then it was strengthened by the p-value results from the Anova Two Way analysis results, namely the p-value compared to the significance level of 0.05. The results of the Anova Two Way calculation obtained a p-value of 0.000 (<0.05), therefore it can be concluded that Ho is rejected and Hi is accepted because the p-value < the significance level (0.000 <0.05) which means that there is a difference between the level of Technological Pedagogical Content Knowledge (TPACK) of high, medium, and low teachers on the learning outcomes of grade X students in Economics subjects.

Hypothesis three tested in this study is "there is a interaction effect between the learning model and the teacher's Technological Pedagogical Content Knowledge (TPACK) on the learning outcomes of grade X students in Economics subjects". Based on the results of the Anova Two Way calculation, the Fcount value is 0.69. Then these results were consulted with Ftable at the 5% significance level, with V1 = 1 and V2 = 70, so that Ftable was obtained at 3.98. In this research, hypothesis one test Ho is rejected and Hi is accepted because Fcount< Ftable (0.69< 3.98). Therefore, it can be concluded that there is no interaction effect between the learning model and the teacher's Technological Pedagogical Content Knowledge (TPACK) on the learning outcomes of grade X students in Economics subjects. Then it was strengthened by the p-value results from the Anova Two Way analysis results, namely the p-value compared to the significance level of 0.05. The results of the Anova Two Way calculation obtained a p-value of 0.504 (>0.05), therefore it can be concluded that Ho is accepted and Hi is rejected because the p-value > the significance level (0.504> 0.05) which means that there is no interaction effect between the learning model and the teacher's Technological Pedagogical Content Knowledge (TPACK) on the learning outcomes of grade X students in Economics subjects.

There is a difference between the effect of using problem-based learning and discovery learning models on the learning outcomes of grade X students in Economics subjects

The results of hypothesis testing show that learning models affect student learning outcomes in economic subjects. This study used problem-based learning and discovery learning models. The problem-based learning model class obtained an average of 82.33 economic learning outcomes. In comparison, the class taught using the discovery learning model obtained an average of 77.05 economic learning outcomes. Thus, the class taught using the problem-based learning model has higher economic learning outcomes than those taught using the discovery learning model.

The difference in economic learning outcomes is based on the characteristics of these two learning models in constructing students' cognition. The class taught using the problem-based learning model has higher economic learning outcomes because, in this learning model, students get knowledge from examples of real problems around them to understand better the concept of the material being studied. This can be seen in the 1st and 4th problem-based learning steps, namely orien-

ting students to the problem and developing and presenting artifacts and exhibits. In orienting students to the problem step, students are directed to criticize real issues relevant to the studied material. Then, in the develop and present artifacts and exhibit step, students can develop solutions to solve existing problems.

These results are in line with the research conducted by Wabula et al., (2020), which proves that the problem-based learning model emphasizes the introduction to the problem and the investigation of problems that students already know from the beginning of the meeting. The learners are also active in planning the investigation together with their group mates. Then, Winarsih, et al., (2019) also stated that problem-based learning is a learning model that presents a significant problem to students as the first step in the investigation. This learning model will increase the critical thinking and the activity of students through the presentation of problems to be investigated. The primary goal of this learning model is to solve students' problems, thereby improving their performance significantly.

The success of the problem-based learning model is in line with the results of previous research and the theory of constructivism. Constructivism theory states that learners can conclude a new concept with the knowledge they have experienced and construct their knowledge. Learners must be active, understand what they must understand, and focus on the problem aspect. With the knowledge gained independently, the knowledge lasts long. The research conducted by Janah et al. (2018), Djonomiarjo (2018), and Wulandari & Surjono (2013) proves that the problem-based learning model affects learning outcomes with higher learning outcomes compared to the control class.

The class taught with the discovery learning model, a student-centric approach that allows students to develop thinking skills based on self-acquired information, also showed improved learning outcomes. This model, where students actively participate in their learning, can be observed in the 3rd and 4th steps of collection and data processing. In the data collection step, learners and their groups are given the opportunity to gather relevant information, which is then used to validate or refute a hypothesis.

Then, in the data processing step, students generalize data to gain new knowledge about alternative answers that must be proven logically. In line with research by Ikalor et al. (2019) that through learning with the discovery learning model, students are encouraged to build their knowledge through the stages of discovery learning, especially at the stage of discussing with their group members, it will increase students' confidence in working on and understanding the material provided. Anisa et al. (2021) also stated that discovery learning can accustom students to cooperate more, have a sense of responsibility between their groups, and dare to express their opinions. Then, the results of research conducted by Dahlan et al. (2023), Putri et al. (2024), and Windiyani et al. (2020) also prove that the discovery learning model affects learning outcomes.

The cause of the difference in Economic learning outcomes in the application of this learning model is in accordance with research conducted by Asmal (2023), namely the step of planning the investigation in the problem-based learning model is not found in the discovery learning model. In the problem-based learning model, students are encouraged to increase activeness in learning, problem solving skills, and students become thinkers in facing complex challenges. The discovery learning model also emphasizes the importance of understanding the structure or important ideas of a science through the active involvement of students in learning, the teacher also acts as a guide by providing opportunities for students to learn. However, the problem-based learning model has the advantage of designing a learning atmosphere for students to solve problems both individually and in groups.

There is a difference between the level of Technological Pedagogical Content Knowledge (TPACK) of high, medium, and low teachers on the learning outcomes of grade X students in Economics subjects

Based on the results of hypothesis testing using Anova Two Way, it shows that the level of Technological Pedagogical Content Knowledge (TPACK) of teachers affects student learning outcomes in Economics subjects. Learners with a high level of teacher TPACK have higher economic learning outcomes compared to students with moderate and low levels of teacher TPACK. It is proven by the average score of Economic learning outcomes obtained by these students. The students with a high level of teacher TPACK obtained an average score of 85.96 on economic learning outcomes. Meanwhile, students with a medium level of teacher TPACK obtained an average score of 77.93 and students with a low level of teacher TPACK obtained an average score of 72.54.

TPACK is an integration of knowledge and skills regarding materials and pedagogics combined in technological advances. It can be stated that TPACK is one of the things that can affect student learning outcomes. Research conducted by Ruaida et al., (2023) also proves that TPACK integration has a significant effect on student learning outcomes and motivates students in the classroom learning process. Amelia et al. (2023) stated that the need for integration between teaching content and teachers' pedagogic abilities with technology so that the implementation of TPACK in each subject is effective for improving student learning outcomes.

Then, the results of Kurniasari & Mardikaningsih's research (2022) also prove that TPACK makes students interested in learning so that students understand the subject matter provided by the teacher and directly impacts on increasing student learning outcomes and also makes it easier for teachers to integrate technology with pedagogical content. Shamim et al., (2024) proved that TPACK integration can develop better teaching practices. Effective learning strategies and techniques should be used to direct the learning process and that different teaching techniques have different impacts on learning.

There is no interaction effect between the learning model and the teacher's Technological Pedagogical Content Knowledge (TPACK) on the learning outcomes of grade X students in Economics subjects

The results of hypothesis testing using Anova Two Way show no interaction between learning models and technological pedagogical content knowledge (TPACK) and student learning outcomes in economics subjects. This is because the class taught with a problem-based learning model with high teacher TPACK is as good as the class taught with a discovery learning model with high teacher TPACK. Students taught with the problem-based learning model with high teacher TPACK had an average score of 87.78, and students taught with the discovery learning model with high teacher TPACK had an average score of 83.64. Learners taught with problem-based learning models with medium teachers TPACK had an average score of 78.30, and learners taught with discovery learning models with medium teachers TPACK had an average score of 77.20. Then, students taught with the problem-based learning model with low teacher TPACK had an average score of 75.13, and students taught with the discovery learning model with 71.25 teacher TPACK.

In addition, the tool used to measure the level of teachers' TPACK in this study still needs to be revised because it only uses questionnaires based on students' perceptions. The level of teachers' TPACK in this study was not measured based on the competence of teachers who taught in the experimental class. Sahidin et al. (2022) stated that TPACK is a framework that serves to think about the knowledge that teachers must have to integrate technology into teaching and how they can develop their knowledge. The TPACK framework measures and evaluates teachers' teach-

ing knowledge and is expected to be the basis for improving learning programs for teachers and prospective teachers.

The results of this study can be used as a reference for teachers and prospective teachers to improve the quality of the learning process. In the subject of Economics, the problem based learning and discovery learning models as well as the teacher's TPACK level have been proven to have a different influence on students' Economics learning outcomes. Teachers are advised to use the problem-based learning model in Economics subjects, because it has been proven to have a significant effect on students' Economics learning outcomes. With a focus on orienting students to the problem and developing and presenting artifacts and exhibits. Teachers are expected to improve their Technological Pedagogical Content Knowledge (TPACK). Because these competencies affect students' Economics learning outcomes, especially on pedagogical knowledge indicators by participating in workshops related to learning models. Teachers are advised to integrate the problem-based learning model with Technological Pedagogical Content Knowledge (TPACK) to improve students' Economics learning outcomes.

CONCLUSION

Based on the results of the analysis and discussion of this study, The problem-based learning model proved to be better when compared to the discovery learning model, because the average score of Economics learning outcomes of students taught using the problem-based learning model was higher than the average score of Economics learning outcomes of students taught using the discovery learning model. But both learning models are equally good when combined with high teacher TPACK levels. Because, students with high teacher TPACK get better learning outcomes compared to students with medium and low teacher TPACK.

This research still has limitations, the measuring tool used to measure teacher TPACK is still not accurate, because it only uses a questionnaire from the student's perspective. So that other researchers are expected to develop this research by measuring teachers' Technological Pedagogical Content Knowledge (TPACK) with a measuring tool that is more tested for feasibility nationally and further research is expected to develop this research with a wider scope, by using different learning models with different reviews.

REFERENCES

Amelia, D. P., Oktafianti, M., Genika, P. R., & Luthfia, R. A. (2023). Implementasi Technological Pedagogical Content Knowledge (TPACK) terhadap Keterampilan Mengajar di Sekolah Dasar. *Journal on Education,* 5(2), 3001–3009.

Aminah, I. A. N., & Sya'bani, M. A. Y. (2023). Implementasi Kurikulum Merdeka dalam Pembelajaran PAI. *Jurnal Pendidikan Islam AL-Ilmi*, 6(2), 293–303.

Anisa, N., Anisa, A., & Irmawanty, I. (2021). Pengaruh Model Pembelajaran Discovery Learning Terhadap Hasil Belajar Biologi Pada Materi Fungi. *Jurnal Binomial*, 4(1), 26–37.

Ardianti, R., Sujarwanto, E., & Surrahman, E. (2021). Problem-based Learning; Apa dan Bagaimana. *DIFFRACTION: Journal for Physics Education and Applied Physics,* 3(1), 27–35.

Asmal, M. (2023). Perbandingan Model Pembelajaran Problem Based Learning Dan Discovery Learning Terhadap Hasil Belajar Siswa. *Sigma*, 5(2), 5413–5420.

Azwar, S. (2012). Penyusunan skala psikologi edisi 2. Yogyakarta: Pustaka Belajar.

Budiyono. (2016). Statistika untuk penelitian edisi ke-2. Surakarta: UNS Press.

Bulotio, J.M., Suriani, N.W., & Rumampuk, R.J. (2020). Pengaruh metode eksperimen menggunakan model problem based learning (PBL) terhadap hasil belajar siswa pada materi larutan elektrolit dan non elektrolit. *Oxygenius Journal of Chemitry Education,* 2(2), 47-51

Dahlan, R. R., Sugiarti, S., & Hasri, H. (2023). Pengaruh Model Discovery Learning terhadap Kemampuan Berpikir Kritis dan Hasil Belajar Redoks Peserta Didik SMAN 2 Buru. *Chemistry Education Review (CER),* 6(2), 141.

Dakhi, A. (2020). Peningkatan Hasil Belajar Siswa. *Jurnal Pendidikan Indonesia,* 1(3), 350–361.

Djonomiarjo, T. (2018). Pengaruh Model Problem Based Learning Terhadap Hasil Belajar. *Jurnal Ilmu Pendidikan Nonformal Aksar*, 05, 39–46.

Fransiska, W., & Ain, S.Q. (2022). Kesulitan Guru Dalam Menerapkan Model-Model Pembelajaran Berdasarkan Kurikulum 2013 di Sekolah Dasar. *Scaffolding: Jurnal Pendidikan Islam dan Multikulturalisme,* 4(1), 309-320.

Ikalor, A., Jamaluddin, & Rasmi, D. A. C. (2019). Efektivitas Penerapan Model Discovery Learning Terhadap Peningkatan Kemampuan Berpikir Kritis Dan Penguasaan Konsep Biologi Siswa Kelas Vii Smp Negeri 19 Mataram Tahun Ajaran 2015/2016. *Jurnal Ilmiah Pendidikan Indonesia*, 1(2), 153–161.

Janah, M. C., Widodo, A. T., & Kasmui, D. (2018). Pengaruh Model Problem Based Learning Terhadap Hasil Belajar Dan Keterampilan Proses Sains. *Jurnal Inovasi Pendidikan Kimia,* 12(1), 2097–2107.

Kaban, R. H., Anzelina, D., Sinaga, R., & Silaban, P. J. (2021). Pengaruh Model Pembelajaran PAKEM terhadap Hasil Belajar Siswa di Sekolah Dasar. *Jurnal Basicedu*, 5(1), 102–109.

Koehler, M. J., Mishra, P., & Cain, W. (2009). What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education*, 193(3), 60–70.

Kurniasari, P., & Mardikaningsih, A. (2022). Penerapan Model Pembelajaran Technological Pedagogical Content Knowledge (TPACK) Berbasis Android Untuk Meningkatkan Hasil Belajar Mahasiswa. *Jurnal Teknologi Pembelajaran (JTeP)*, 2(2), 1–8.

Maulinda, U. (2022). Pengembangan Modul Ajar Berbasis Kurikulum Merdeka. *Tarbawi*, 5(2), 130–138.

Muthik, A., Muchyidin, A., & Persada, A.R. (2022). The effectiveness of students' learning motivation on learning outcomes using the reciprocal teaching learning model. *Journal of General Education and Humanities (GEHU)*, 1(1), 21-30

Muthoharoh, M. (2023). Kurikulum Merdeka: Konsep dan Impelemtasiannya. *Tabyin:Jurnal Pendidikan Islam,* 05(01), 125–132.

Muzana, S. R., Jumadi, Wilujeng, I., Yanto, B. E., & Mustamin, A. A. (2021). E-STEM project-based learning in teaching science to increase ICT literacy and problem solving. *International Journal of Evaluation and Research in Education,* 10(4), 1386–1394.

Nasution, A. ., Ningsih, S., Silva, M. ., Suharti, L., & Harahap, J. . (2023). Konsep Dan Implementasi Kurikulum Merdeka. *COMPETITIVE: Journal of Education,* 2(3), 201–211.

Octoria, D., Ganendra, A., & ... (2023). Pengaruh Pedagogical Knowledge Terhadap Kinerja Mahasiswa Program Pendidikan Profesi Guru Dengan Moderasi Communication Skills. … *Jurnal Pendidikan* …, November, 2855–2868.

Pattiasina, J., & Sopacua, *Jems. (2022). The Effectiveness Of Problem Based Learning Model In Increasing Historical Learning Outcomes. *Riwayat: Educational Journal of History and Humanities,* 5(2), 361–368.

Puspitasari, Y., & Nurhayati, S. (2019). Pengaruh model pembelajaran discovery learning terhadap hasil belajar siswa. *Jurnal Ilmu Pendidikan*, 7(1), 91–106.

Putri, E. R. W., Manda, T. G., & Meutia, M. (2024). Pengaruh Model Pembelajaran Discovery Learning Terhadap Hasil Belajar Matematika Peserta Didik Kelas Ix Smp Negeri 6 Padang. *Jurnal Edukasi Dan Penelitian Matematika,* 13(1), 188–191.

Rahmadi, I. F. (2019). Technological Pedagogical Content Knowledge (TPACK): Kerangka Pengetahuan Guru Abad 21. *Jurnal Pendidikan Kewarganegaraan,* 6(1), 65.

Ruaida, Zulfadhli, & Ningrum, S. W. (2023). Pengaruh Penerapan TPACK Terhadap Hasil

Belajar Siswa Dalam Mata Peljaran Ekonomi Kelas X di SMAN 3 Banda Aceh. *Jurnal Economica Didactica,* Vol 4.(2), 29–34.

Sahidin, L., Kadir, Salim, & Prajono, R. (2022). Eksplorasi TPACK dalam Mendukung Keterampilan Berpikir Tingkat Tinggi (Exploration of TPACK in Supporting High Order Thinking Skills). *Jurnal Pendidikan Matematika*, 13(2), 212–227.

Shamim, M. R., Jeng, A. M., & Raihan, M. A. (2024). University teachers' perceptions of ICT-based teaching to construct knowledge for effective classroom interaction in the context of TPACK model. *Heliyon*, 10(8), e28577

Sinabariba, R. B. (2017). Peranan Guru Memilih Model-Model Pembelajaran Untuk Meningkatkan Kemampuan Menulis Puisi. *Seminar Nasional Pendidikan Dasar Universitas Negeri Medan,* 67–74.

Suindhia, I. . (2023). Pengaruh Penerapan Model Pembelajaran Problem Based Learning (PBL) Terhadap Hasil Belajar Fisika. *TEACHING : Jurnal Inovasi Keguruan Dan Ilmu Pendidikan*, 3(1), 49–56.

Tania, R., Jumadi, & Astuti, D. P. (2020). The Application Of Physics E-Handout Assisted By PBL Model Use Edmodo To Improve Critical Thinking Skills And ICT Literacy Of High School Students. *Journal of Physics: Conference Series,* 1440(1).

Wabula, M., Papilaya, P. M., & Rumahlatu, D. (2020). Pengaruh Model Pembelajaran Discovery Learning Berbantuan Video Dan Problem Based Learning Terhadap Motivasi Dan Hasil Belajar Siswa. *Edubiotik : Jurnal Pendidikan, Biologi Dan Terapan,* 5(01), 29–41.

Wabula, M., Papilaya, P. M., & Rumahlatu, D. (2020b). Pengaruh Model Pembelajaran Problem Based Learning Dan Inquiri Based Learning Terhadap Motivasi Dan Hasil Belajar Siswa. *Edubiotik : Jurnal Pendidikan, Biologi Dan Terapan*, 5(1), 29–41.

Winarsih, S., Sangka, K. B., & Octoria, D. (2019). The effect of direct instruction and problem based learning on millennial. *AIP Conference Proceedings*, 2194 .

Windiyani, T., Novita, L., & Sakinah, A. R. (2020). Pengaruh Penerapan Model Discovery Learning Terhadap Hasil Belajar Matematika Siswa. *Widyagogik : Jurnal Pendidikan Dan Pembelajaran Sekolah Dasar*, 7(2), 148–163.

Wulandari, B., & Surjono, H. D. (2013). Pengaruh problem-based learning terhadap hasil belajar ditinjau dari motivasi belajar PLC di SMK. *Jurnal Pendidikan Vokasi*, 3(2), 178–191.

Wungguli, D., & Yahya, L. (2020). Pengaruh Penggunaan Media Berbasis Information and Communication Technology (ICT) terhadap Hasil Belajar Siswa pada Materi Dimensi Tiga. *Jambura Journal of Mathematics Education*, 1(1), 41–47.

Yurinda, B., & Widyasari, N. (2022). Analisis Technological Pedagogical and Content Knowledge (TPACK) guru profesional dalam pembelajaran matematika di Sekolah Dasar. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika,* 8(1), 47–59.