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IMPLEMENTATION OF TPACK APPROACH TOWARD CRITICAL THINKING ABILITY AND COGNITIVE LEARNING OUTCOMES OF STUDENTS OF SMA NEGERI 1 JAKENAN ON ENVIRONMENTAL CHANGE MATERIAL

Dina Khoiril Ma'sumah, Atip Nurwahyunani*
Pendidikan Biologi, Universitas PGRI Semarang. Jl. Dr. Cipto Sidodadi Timur No. 24, Semarang
**Corresponding author: atipnurwahyunani@upgris.ac.id*

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ABSTRACT

TPACK is a framework that identifies the knowledge that teachers need to teach effectively with a technology framework. The TPACK approach helps develop teachers' ability to use technology to think critically toward achieving student learning outcomes. This study aims to determine the application of the TPACK approach in developing critical thinking skills and learning outcomes in environmental change material. The subjects of this study were class X-7, the control class, and X-12, the experimental class with 72 students. The sampling technique used was purposive sampling. The method used in this study was quantitative, using teaching module instruments, pretest-posttest questions, and worksheets. The results of the critical thinking skills of the experimental class showed an average score of 4.67 in the good category, while the control class got an average score of 4.11 in the good category. The final analysis of learning outcomes obtained differences in learning outcomes in environmental change material with an average posttest score of the experimental class of 85.83, while in the control class, the posttest score was 70.00. Hypothesis Test analysis testing using the T-test obtained count (15,375) > table (1.666) = 0.05, HO is rejected, H1 is accepted. Based on the results of the study, the TPACK approach influences the development of critical thinking skills and learning outcomes of students of SMA Negeri 1 Jakenan on environmental change material.

INTRODUCTION

Learning biology in today's students is expected not only to know, but of course, they must be able to understand concepts in biology. However, I can apply understanding in everyday life, especially critical thinking skills, and solve biology-related problems.

Because the current build-up of science and technology is increasing rapidly, demanding that the world of education must improve the quality of education. Education can be improved by changing the mindset that is used as the basis for implementing learning. Thus, TPACK can be used to develop biology learning (Surata et al., 2020).

Based on interviews conducted by researchers on Wednesday, 23 November 2022, at SMA Negeri 1 Jakenan, it can be seen that many students' critical thinking skills are still lacking, especially during the learning process; many students are still not paying attention. In terms of answering questions, it makes students still not quite right, and in conclusion, student material is still less flexible in delivery. The leading cause is that students are less focused during learning. This results in the achievement of student learning outcomes at Jakenan 1 Public High School. Many still have not reached the KKM (Maximum Completeness Criteria) because the scores are still rated between 50 and 60. This means that the learning outcomes at Jakenan 1 Public High School still have much value. Students who are lacking in achieving KKM (Maximum Completeness Criteria) with a score of 70.

On the other hand, teachers at SMA Negeri 1 Jakenan use a discovery learning approach and discussion methods. It still has not reached students' critical thinking skills. On the one hand, critical thinking is important to achieve learning outcomes. Critical thinking influences the ability to live and function in all aspects of life. Various research results show that critical thinking can prepare students to think in various disciplines and can be used to set up learners to live in real life (Zubaidah, 2010). Critical thinking is complex, so when processing for optimal learning outcomes, the factors to achieve learning outcomes need to be controlled as well as possible. The results of interviews regarding environmental change material in class X, even in the semester, are often considered less interesting and dull material. Based on the problem interviews on this material, many students are still reluctant to study the material more deeply. Constraints in other matters when face-to-face learning is limited, students take turns every day so that efforts to provide direct guidance are still not optimal. To minimize the problem of environmental change, it is better taught using methods that require students to be active during learning and student-centered so that students can build their knowledge, understand more efficiently, and are not quickly bored with the material (Putri et al., 2014).

Learning outcomes encompass a range of behavioral patterns, values, perspectives, attitudes, appreciations, and skill sets. (Widodo & Widayanti, 2014). So that understanding concepts does not yet require students to be active and train students in thinking and discovering existing concepts themselves, students tend to memorize concepts more often without knowing how to process concepts, resulting in a lack of student ability to think critically for problem-solving 2 at SMA Negeri 1 Jakenan. The learning outcomes obtained by students are not satisfactory because the selection of learning approaches and methods is less varied; teachers often use the lecture method so that students' attention in learning biology is reduced, and students feel bored with the class atmosphere. Teachers have not yet optimized various learning methods, so students' activeness and critical thinking skills in biology are still low (Khanifah et al., 2012).

The TPACK approach can minimize problems in critical thinking and student learning outcomes. TPACK is knowledge of technological pedagogic content through combining content knowledge, pedagogic abilities, and technology integration in the learning process, which is very important (Mishra, 2019).

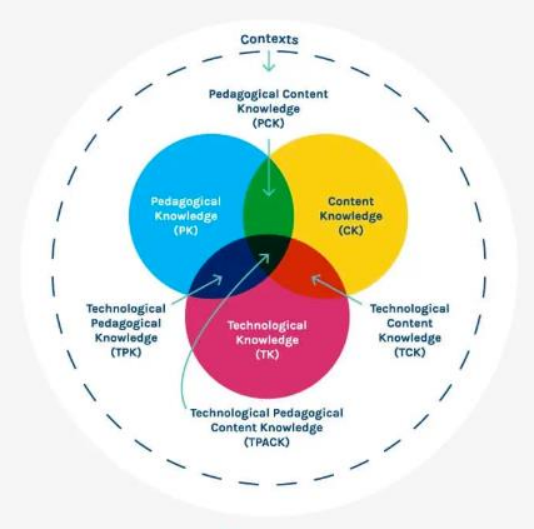

Figure 1. The TPACK Framework and Its Knowledge Components (Koehler et al, 2013)

According to Koehler and Mishra, there are seven elements of TPACK, which are then called seven domains of knowledge, namely:

Pedagogical Knowledge (PK) or Pedagogical Knowledge

This contains knowledge teachers must master in learning, such as classroom management, teaching methods, learning planning, student activity assessment, and others. Important information is presented chronologically

Content Knowledge (CK)

CK is related to the substance of the material that teachers must master in learning. Mastery of this material affects student understanding.

Technological Knowledge (TK)

I don't know if TK explains the importance of teachers integrating technology into learning. Technology can be used in communication, student data processing, learning activities, and others.

Pedagogical Content Knowledge (PCK)

PCK focuses on the learning process teachers will later choose on the material being taught. This may not be enough to select teaching methods, lesson plans, and supporting learning facilities.

Technological Content Knowledge (TCK)

TCK elements are knowledge about the influence of technology on specific scientific disciplines. This means how much influence technology has on developing a scientific discipline.

Technological Pedagogical Knowledge (TPK)

TPK contains the relationship between technology and the learning process. Through TPK, teachers can understand the advantages and disadvantages of technology in learning, which can later be used as evaluation material.

Technological Pedagogical Content Knowledge (TPACK)

The last is TPACK, which integrates the three components, namely technology, pedagogy, and learning content. In this digital era, teachers are required to be proficient in the integration of the three.

So, TPACK is a powerful tool for teachers to improve the quality of teaching in the digital era by combining technology, pedagogical, and content skills. With the relevance of the media used in SMA Negeri 1 Jakenan using PPT made by the teacher, the contents in the PPT already include explanations and involve pictures of material relationships. Google Classroom can also be used for learning, and teachers and students can access it.

As for the collection of assignments, they are usually collected via email and Google Forms. The development of science and technology can be used to improve the quality of learning conducted by an educator. Based on this statement, it is necessary to have a learning approach that combines material, pedagogic, and technology to support the development of critical thinking skills to achieve student learning outcomes (Farikah, Moch. Malik Al Firdaus & Yuwono, 2019).

MATERIALS AND METHODS

This study used an experimental research design (Quasi Experiment) with a Non-Equivalent Control Group Design. The population in this study were students of class X SMA Negeri 1 Jakenan, with a total of 432 students. The sample used in this study was class X-7 and X-12, with 72 students, with one class as an experimental class and one as a control class. This study used two subject classes: the experimental class, which received the TPACK learning treatment, and the control class, which received the conventional learning treatment. The experimental and control classes each consisted of 36 students of class X SMA. The learning treatment was carried out for two face-to-face meetings for each class with a time allocation of 2JP (2x45 minutes) for each meeting. Instruments for measuring learning outcomes use pretest-posttest questions, LKPD, performance, and measurement of critical thinking skills using validated response questionnaires. Analysis of learning outcomes data using the Manova test followed by hypothesis testing to see the effect of implementing the TPACK approach in learning, then for analysis of response questionnaire data using the percentage formula as follows:

$$P = \frac{f}{N} x100\%$$

Information:

P = Percentage Number

F = The frequency that the presentation is looking for

N = Number of Case (number of frequencies of individuals)

RESULTS AND DISCUSSION

Average Percentage Results of Critical Thinking Performance of Experimental Class Students

The critical thinking response data of students in the experimental class was calculated and analyzed using the data obtained from the video product (**Table 1**).

Table 1 The average results of the Critical Thinking Ability Questionnaire of

Indicator	A	B	C	D	E
Average score	4.37	3.40	3.35	4.67	4.25

Experimental Class Students

Color Description:

= Lowest = Highest Indicator Description

A : Give a simple explanation

B : Build basic skills

C : Making inferences

D : Make further explanation

E : Set strategy and tactics

The results of the average percentage value of questions with the highest answers in the experimental class are in the critical thinking ability indicator, namely making further explanations with a score of 4.67 (green), while the results of the average percentage value of questions with the lowest answers in the experimental class are in the critical thinking ability indicator, namely Making inferences with a score of 3.35 (yellow).

Results of Average Percentage of Critical Thinking Performance of Control Class Students

The critical thinking response data of students in the experimental class was calculated and analyzed using LKPD data (**Table 2**).

Table 2. Average Results of the Control Class Critical Thinking Ability Questionnaire

Indicator	**A**	**B**	**C**	**D**	**E**
Average Score	4.11	3.86	3,31	3,52	4.04

Color Description:

= Lowest = Highest Indicator Description

A : Give a simple explanation

B : Build basic skills

C : Making inferences

D : Make further explanation

E : Set strategy and tactics

The results of the average percentage value of questions with the highest answers in the control class are in the critical thinking ability indicator, namely providing a simple explanation with a score of 4.11 (green), while the results of the average percentage value of questions with the lowest answers in the control class are in the critical thinking ability indicator, namely making inferences with a score of 3.31 (yellow).

Hypothesis test (t-test)

The t-test results were based on the One Sample T-test to determine students' critical thinking skills in learning using the TPACK approach (**Table 3**).

Table 3. Hypotesis Test

	t	df	Sig.(2-tailed)	Mean Difference
Critical Thingking	9.102	72	0.000	62.597

The results of the hypothesis test using the One Sample test show that the critical thinking ability variable has a count of 9.102. The table value for the critical thinking ability variable is 1.666. The results of the test that have been carried out can be concluded that count (9.102) > table (1.666), namely H0, is rejected H1 accepts that there is an influence of critical thinking ability between students who learn using the TPACK approach and students who follow conventional learning.

Pretest and Posttest Data on Learning Outcomes of Experimental and Control Class Students

The data used in this study are pretest and posttest scores to determine the cognitive learning outcomes of the experimental and control classes. The experimental class uses the TPACK approach in learning activities, while the control class uses a conventional approach. The learning outcomes of the pretest and posttest scores in the experimental class and the control class (**Table 4**).

Table 4. Pretest and Posttest Results of Experimental Class and Control Class

Kelas	N	Pretest	Posttest
Experimen	36	51,80	85,83
control	36	38,75	70,00
range		13,05	15,83

Table 4 shows that student learning outcomes in pretest and posttest scores obtained different results. The experimental class obtained a pretest score of 51.80, while the control class obtained a pretest score of 38.75 with a difference of 13.05. This means that in the early stages, the experimental class was given treatment using the TPACK approach, and the control class had a significant difference.

The experimental class obtained a posttest score of 85.83, while the posttest score in the control class was 70.00, with a difference of 15.83. This means that in the final stage of learning or posttest, the experimental class used the TPACK approach, and the control class used the conventional approach, which had a difference with sufficient results. So, the increase in pretest and posttest scores from the experimental class day was 34.03. While in the control class, the pretest and posttest scores got an increased distance of 31.25. The results of the difference in pretest and posttest scores for the experimental and control classes were 2.78.

Hypothesis Test (T-Test)

A hypothesis test is used to determine learning outcomes in learning using the TPACK approach. This analysis is used to test the significance of differences in learning outcome values in the experimental class and the control class (**Table 5**).

Table 5. Hypotesis tes

	t	df	Sig. (2-tailed)	Mean Difference
Outcomes result	15.375	72	0.000	80.670

Based on the hypothesis test, it is known that the learning outcome variable gets a t count result of 15,375, and the t table value for the learning outcome variable is 1.666. So t count> t table, then H0 is rejected, and H1 is accepted. The test results obtained can be concluded t count (15,375)> t table (1.666) then H0 is rejected, and H1 is accepted, namely that there is an influence of learning outcomes between students who carry out learning using the TPACK approach and students who follow conventional learning.

Implementation of the TPACK approach to students' critical thinking skills in environmental change material for class X SMA N 1 Jakenan

The results obtained in Tables 1 and 2 are the results of critical thinking skills with data analysis on videos for the experimental and control classes in the form of LKPD. The results obtained by the experimental class and the control class got different scores. The difference in results obtained was because when filling in the work, students did not

match what was done during the learning process, and there were still those who paid less attention to what was conveyed by the teacher.

Indicators Provide Simple Explanations

The average critical thinking ability questionnaire indicator results provide simple explanations for the experimental class, namely 4.37. In contrast, the control class got a 4.11 result from these results in the sufficient category. These results, by providing simple explanations, students can understand the material, but students are less able to analyze the arguments presented by the teacher perfectly; students can listen when their friends equate an argument, and some dare to ask when there is material that students do not yet understand.

With the categories obtained, students have formulated the initial main problem to understand better what is not yet understood (Erwanto, 2020). Providing simple explanations at the beginning of learning also brings insights into each meaning related to the initial analysis of learning (Sunardjo et al., 2016).

Basic Skills Building Indicators

The results obtained from the average critical thinking ability of the basic skills-building indicator in the experimental class were 3.40, while in the control class, the results were 3.86. These results showed that it had a sufficient category in the experimental and control classes. In the experimental class, students were able to consider the truth by looking at relevant sources such as the internet and books, and students were also able to observe a problem that existed around the school related to environmental changes by considering the right results. The results obtained in the control class were because there were still students who were less careful in considering the truth by looking at relevant sources, and students who observed problems were less flexible or less careful in considering the results obtained.

Learning by considering relevant sources related to case studies can help train students in critical thinking (Kurniasih, 2017). Considering relevant sources to be trusted to solve a problem (Pijayani, 2016).

Inference Making Indicator

The results obtained from the average critical thinking ability of the inference-making indicator in the experimental class were 3.35, while in the control class, it was

3.31. From these results, it was in the sufficient category. The results showed that students could re-explain the material that the teacher had delivered to their friends, students were able to increase their insight by reading from accurate sources, students were also able to listen to arguments given by their friends to increase their insight related to the material, and students could conclude the opinions expressed by their friends.

In the inference-making indicator, they cannot identify and solve problems until they find specific conclusions (Maslakhatunni'mah, 2019). In conclusion, the inference-making indicator is used so that students can think more critically and interpret what has happened and been observed (Kosasih, 2015).

Further Explanation Indicator

The results obtained from the average critical thinking ability of the further explanation indicator of the experimental class were 4.67. In contrast, in the control class, 3.52 of these results had a sufficient category. The results showed that students could consider the conclusions made, students were able to provide re-explanations regarding terms that were not yet understood by their friends using simple sentences, students always thought first before conveying their arguments to friends, and students always noted terms that were difficult to understand during learning so that they could recall the material.

Students' further explanation abilities were carried out by implementing discovery-based learning in observations by training critical thinking skills during observation (Duran & Dökme, 2016). Many problems emerged due to observing and considering the results (Sunardjo et al., 2016).

Arranging strategies and tactics

The results obtained from the average critical thinking ability indicator for arranging strategies and tactics in the experimental class were 4.25, while the control class was 4.04. These results have a sufficient category. These results show that students can decide on an action by asking the teacher; students are not too often asked when discussing in groups.

Students' critical thinking skills can be identified from how they respond to a problem. In addition, they show activeness in asking questions to obtain precise information, seriousness in working on problems to get logical solutions, dare to express

opinions and put forward rational ideas, and can draw conclusions from existing solutions (Yuan et al., 2015). Organizing strategies and tactics determine student actions in making specific decisions (Khoirunnisa & Sabekti, 2020).

Calculation of the results of the hypothesis test of the critical thinking ability variable, it can be concluded that t count (9.102) > t table (1.666) then H0 is rejected, H1 is accepted, namely that there is a difference in the results of critical thinking abilities between students who take learning using the TPACK approach and students who take learning in conventional classes. In thinking about students' critical thinking abilities, it is essential to know in advance because before determining the implementation of a good learning design for students, it is necessary to know in advance how high the level of students' critical thinking abilities is, what obstacles or problems are experienced so that the selection of the application of approaches in learning can be carried out effectively (Roshayanti, 2022). The critical thinking skills carried out by students are important to develop because learning in today's era is not enough just to have the ability to remember; it must be able to analyze, solve problems, identify, and develop the reasoning that is owned. Critical thinking is analyzing and evaluating information obtained from observations, experiences, and knowledge accompanied by concrete evidence to determine right and wrong (Firdauzi et al., 2019). Students' critical thinking abilities must be possessed to help them build their knowledge and cognitive reasoning. Because education today increasingly prioritizes critical thinking in students. Critical thinking is finding the correct answer by finding information to solve a problem calmly, not being emotional, prioritizing logic, understanding the problem, and analyzing and evaluating the results before deciding or taking action (Minarti, 2023).

Through observing and analyzing problems, students are required to think more critically, and these activities help students develop critical thinking skills in studying environmental change material. When making observations, each student has different opinions, which unite their arguments and opinions regarding problems around the school to get good critical thinking results (Retno Mulyaningrum, 2017). Good understanding and mastery are obtained if students learn directly about the main problem and later have a good effect on obtaining the results of finding their learning concepts. In the learning process, students are directly involved in observing problems that occur in their environment and can build their knowledge by asking questions and communicating

through a discovery process that gives students a more accurate and active learning experience so that students are more actively trained in taking on the preparation of answers (Nurwahyunani, 2017). In developing critical thinking skills, activities such as observing, reporting, solving problems, analyzing an idea or idea, distinguishing, identifying, reviewing, and developing logical and reliable reasoning are involved so that critical thinking can support improved learning in the current century (Roshayanti, 2023).

Implementation of the TPACK Approach to Student Learning Outcomes on Environmental Change Material in Class X of SMA N 1 Jakenan

Based on the study results at SMA N 1, Jakenan obtained significant results with the TPACK approach to learning outcomes. This is proven by the results obtained on the posttest value of environmental change material, which got higher results than the posttest value in the conventional class. In the experimental class, the quiz application contained instructions for filling in and pretest and posttest questions for the experimental class. Filling in the pretest begins before being given the material, while the posttest is given after the learning ends. The performance and learning outcomes results in the experimental class X12 are included in the high category. This provides evidence that the TPACK approach affects learning outcomes in environmental change material, with an average posttest value for the experimental class of 85.83, while in the control class, the posttest value is 70.00. The better the approach used by the teacher, the more it supports relatively high learning outcomes for students (Yulianingsih & Sobandi, 2017). So, the increase in pretest and posttest scores from the experimental class day was 34.03. While in the control class, the pretest and posttest scores got an increased distance of 31.25. The difference in pretest and posttest scores of the experimental and control classes was 2.78. The high student learning outcomes factor is due to the teacher's preparation of the media used during learning so that students can master the material higher than their' knowledge (Nurwahyunani, 2019). The results obtained in the experimental and control classes showed different results. Bloom's cognitive domain is used to measure the success of student learning outcomes in the experimental and control classes. The questions given to students are HOTS questions used by researchers related to learning outcomes in the cognitive domain of analysis, synthesis, and evaluation with levels C4, C5, and C6.

The questions given to students already include elements of cognitive indicators by S. Bloom. The achievement obtained in cognitive learning outcomes has been achieved

where the number of students who achieved the KKM in the experimental class was 32 from a total of 36 students. While in the conventional class in the control class, the KKM was achieved by 25 people from a total of 36 students in the class. According to Ignatius (2020), using the right approach in the teaching process can improve student learning outcomes. Thus, improving learning outcomes can be more optimal because these students feel that learning outcomes must be achieved. Therefore, the achievement of learning outcomes can be influenced by factors including factors within oneself and environmental factors. In other cases, one of the factors that supports the achievement of learning objectives cannot be separated from the model used by the teacher.

The learning model is a method that contains procedures for carrying out learning activities, especially activities in presenting subjects to students, and standard procedures used by teachers to teach in class. In addition, the learning model can help teachers and facilitate material delivery to students. Therefore, a learning model using the learning material will better support the ongoing teaching and learning activities (Gulo, 2022). The development of technology is increasingly advanced and modern, so teachers must be able to utilize the development process in the learning system. The TPACK approach is a way to encourage students to use the right technology. Able to think critically in solving problems in the learning process and encourage students to discuss with each other in their groups to improve the final results of learning outcomes (Nurwahyunani & Azizy, 2023).

The Minister of National Education Regulation emphasized the importance of using technology concerning teacher qualifications and competencies, stating that to increase the effectiveness and efficiency of learning, teachers must master and utilize technology. Therefore, teachers must use technology in learning, starting with the planning, implementation, and assessment stages of learning outcomes (Abroto, 2020). It is not enough to have the content and pedagogical knowledge teachers need for quality teaching; integrating technology is important in instructional practices.

The TPACK approach used by researchers to support a technology-based approach is in the form of the quiz application, while the pedagogy and content are in the form of KI, KD, learning objectives, learning materials, learning evaluation, and content in the form of video products in the experimental class. The existence of the TPACK approach provides teachers with insight into approaches to the classroom learning process to

improve learning outcomes. Implementing the TPACK approach makes students play an active role in searching and finding information supported by the application of technology in their learning process. The more students ask questions, the higher the value of cognitive learning outcomes for students (Roshayanti, 2020).

This is to findings in the field that students play an active role by asking questions, making observations, collecting data from various sources, analyzing data, and coming to conclusions about what is being studied independently but still under the guidance of the teacher so that during the learning process they can hone their thinking skills. Critical students. The application of technology during learning also helps students understand the content of the material and makes it easier for students to find material from various sources (Permatasari et al., 2022).

Applying technology, pedagogy, and content or material knowledge to teachers can help them understand how to approach technology to improve students while also knowing the correct pedagogical and content abilities. The TPACK framework helps teachers understand how to integrate technology into teaching and learning. Thus, the use of TPACK is a strategic way to evaluate or assess the ability to integrate the use of technology in teaching. Content knowledge integrating technology and pedagogical skills is an important requirement in creating effective and innovative classroom teaching using technology. Currently, learning requires mastery of teachers who collaborate with technology. So the three components of pedagogical, content, and technological aspects must be integrated into learning (Sumarno, 2021).

The results obtained the maximum student learning outcomes because knowing and understanding what abilities are conveyed with the concept of critical thinking skills will obtain learning outcomes so that students will achieve maximum achievements. Learning outcomes are the level of success achieved by students during learning, which is stated in the score obtained from the test results on the test that was given (Minarti, 2021). The results of the t-test that have been carried out on the posttest value can be concluded count (15.375)> table (1.666) then H0 is rejected, H1 is accepted, namely that there is an effect of changes in learning outcomes between students in the experimental class and the control class. So, it can be explained that the hypothesis states that "There is an effect of implementing the TPACK approach to developing critical thinking skills and learning outcomes of students at SMA Negeri 1 Jakenan on environmental change material. The

results of the research that has been carried out show that the use of TPACK makes learning more active and more enjoyable by involving students directly in the learning process. The application of the TPACK learning model to learning in class X12 can take place effectively by emphasizing student activities so that students can maximize their abilities.

CONCLUSION

Based on the results obtained from the study, implementing the TPACK approach can develop the critical thinking skills of students of SMA Negeri 1 Jakenan on environmental change material with a t-test result of 9.102 and a t-table of 1.666. Implementing the TPACK approach can develop students' learning outcomes of SMA Negeri 1 Jakenan on environmental change material with a t-test result of 15.375 and a t-table of 1.666. The study's findings indicate that implementing the TPACK approach effectively enhances critical thinking abilities and learning outcomes. The TPACK approach is categorized as sufficient in fostering critical thinking skills. Furthermore, there is a notable difference in learning outcomes between students in the experimental and control groups. Learning through the TPACK approach proves more effective in boosting learning outcomes than traditional methods. This approach showed significant improvement in the learning achievements of Class X students, who served as the sample for this study.

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