Journal of Computer Science Advancements, 2(3) - June 2024 158-175

The Impact of Adaptive Learning Technology on Improving Students' Concept Understanding

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Article Information:
Received May 18, 2024
Revised June 20, 2024
Accepted June 30, 2024

ABSTRACT

Adaptive learning technology is an educational method that uses artificial intelligence and computer algorithms. This learning system can manage students' interaction pattern during learning activities. The use of adaptive learning technology is able to change students from just receiving information to an active and collaborative part in the learning process. This research was conducted with the aim of improving the quality of education in Indonesia by encouraging teachers to use this technology. This research also aims to provide a better understanding of the potential and weaknesses of adaptive learning technology in improving students' concept understanding as well as providing stronger guidance for curriculum development and better educational practices. The method used in this research is quantitative method. This method is a way of collecting numerical data that can be tested. Data is collected through the distribution of questionnaires addressed to students. Furthermore, the data that has been collected from the distribution of the questionnaire, will be accessible in Excel format which can then be processed with SPSS. From the results of the study, it can be seen that the impact of using adaptive learning technology shows that adaptive learning technology can improve the quality of education. Research shows that with the use of adaptive learning technology, it can change teaching methods, learning materials, and can find out the level of learning difficulties faced by these students. From this study, researchers can conclude that the impact of using adaptive learning technology, can improve student understanding and achievement and has the potential to improve the quality of education. with the existence of adaptive learning technology, it is able to increase student involvement and motivation in learning, so that student understanding in learning can be achieved well.

Keywords: *Adaptive Learning, Technology, Understanding*

Journal Homepage https://journal.ypidathu.or.id/index.php/jcsa

How to cite: Soelistianto, A, F., Andrasmoro, D., Yusriati, Yusriati., Mardiati, Mardiati., & Fawait, B, A. (2024). The Impact of Adaptive Learning Technology on Improving Students' Concept Understanding. *Journal of Computer Science Advancements*, 2(3). 158-175 https://doi.org/10.70177/jsca.v2i3.1176
Published by: Yayasan Pendidikan Islam Daarut Thufulah

INTRODUCTION

Education has an important role in preparing educational institutions to produce a young generation who are ready to compete in this era of increasingly advanced technological developments (Brook & Pedler, 2020). Current education places more emphasis on students' abilities to understand concepts, communicate, work together, master information technology, and connect theory with the real world (Pitura & Terlecka-Pacut, 2018). To face competition in the era of globalization, therefore, improving the quality of education is very important to pay attention to. According to the National Education Standards Agency, education does not depend on teaching, instead, education depends on curiosity that motivates students and actions initiated by students themselves (Warren & Marciano, 2018). With the presence of the use of adaptive learning technology, it has become a learning technology that can be adapted to current technological developments.

Learning activities are an educational process that gives students the opportunity to improve their attitudes, knowledge and skills in life in society, nation and state (Akala, 2019). Therefore, learning activities are designed to encourage all students' potential to achieve the expected competencies. Today's learning activities place greater emphasis on the use of learning technology (Bolívar-Chávez et al., 2021). The use of learning technology can improve the overall quality of learning by making learning more interactive, personal, and interesting (Barron et al., 2022). The use of technology allows students to access various learning resources from around the world, such as digital textbooks, interactive simulations, online learning platforms, and learning videos.

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Adaptive learning allows teachers to better track student progress. Teachers can also see how each student responds to lessons and provide additional support if needed (Elangovan & Subedha, 2023). So improvements can be made more quickly, and this adaptive learning system can help identify areas where students may be experiencing difficulties. Adaptive learning increases educational efficiency, so that students can now learn in a more efficient way because students are no longer trapped in a curriculum that does not suit their needs (You et al., 2022). Apart from that, this can increase retention and understanding of the concepts of learning material for students. Adaptive learning can help students with various skill levels according to student learning needs (Özbek & Çelik, 2022).

Machine learning algorithms are an important part of adaptive learning. Machine learning algorithms analyze student data in real-time, which includes a variety of information such as students' level of understanding, learning styles, skills, and more (Lee et al., 2021). Then, this algorithm processes this data to make appropriate recommendations about what learning materials should be provided to each student. This algorithm continues to learn from student responses dynamically so that it can adapt learning materials (Bodyanskiy et al., 2021). Interactive digital content is essential for adaptive learning. This digital content can take the form of simulations, videos, educational games, and so on (Genders & Razavi, 2020). This aims to make learning more interesting and interactive, encouraging students to be more involved in class. This digital content can also be easily tailored to students' abilities and interests.

In addition, online learning platforms play an important role in supporting adaptive learning because they provide a variety of learning materials tailored to students' unique needs (Wang et al., 2023). These platforms allow students and teachers to interact with each other, enable more effective communication, and monitor student progress (Dhingra et al., 2023). Adaptive learning continues to develop as a possible method for improving the quality of education worldwide, as the use of technology has brought a more personalized and effective approach to learning (C. Zhang et al., 2020). The use of adaptive learning technology not only allows students to better reach their potential, but also allows educators to provide more precise and targeted support.

Based on the explanation of the research above, researchers assume that the impact of using adaptive learning technology is very effective in increasing students' understanding of concepts in learning. This could be due to the influence of the increasing development of globalization in technological integration. This research also aims to look at the advantages and disadvantages of the impact of using adaptive learning technology on increasing students' understanding of concepts. And researchers also have a hope that future researchers will research the impact of using adaptive learning technology on increasing students' understanding of concepts, so that they will be researched again in depth and develop research to get maximum results.

RESEARCH METHODOLOGY

Research design

This research uses a quantitative research design, which uses statistical processes to present data in the form of numbers. Researchers created twenty questions to collect information about the research to find out the results. Researchers will ask respondents to answer the questions asked, which will be presented in the form of tables and percentages. The purpose of processing this data with the SPSS application is to compare the results of respondents' answers. After this comparison, researchers can provide solutions for any information they obtain about the impact of using adaptive learning technology on increasing students' understanding of concepts.

Research procedure

In this research, researchers investigated the impact of using adaptive learning technology on increasing students' understanding of concepts. The aim of the researcher is to investigate this matter so that the researcher can collect, analyze and provide understanding of the data that has been collected. In making questions, the researcher used language that was good and easy for respondents to understand when responding to the questionnaire given by the researcher. This aims to ensure that respondents who provide responses to questions asked by researchers can be answered quickly. That way, it will be easier for researchers to test the data being investigated regarding the impact of using adaptive learning technology on increasing students' understanding of concepts.

Research subject

The subjects in this research were students from various educational institutions. Researchers are tasked with collecting data from the respondents' answers, then the data will later be processed and converted into percentages. Before the researcher distributes the questionnaire, the researcher asks for the respondent's willingness and willingness to take the time to fill out the questionnaire. The questionnaire consists of ten questions

about the impact of using adaptive learning technology on increasing students' understanding of concepts.

Research Ethics

In conducting research, researchers pay great attention to manners, ethics, behavior and manners. Because research ethics are the norms, manners and attitudes that researchers have to use as a basis for action. By upholding ethics in research, it will make it easier and faster for researchers to collect data. By using friendly and polite language, other people will easily understand and it will be possible not to put other people's feelings into a corner. Therefore, conducting research in accordance with ethics will have a positive impact on researchers. Apart from that, there is a feeling of security and comfort in conducting research, so that communication and receiving data is easy.

Data Collection and Analysis

This time, researchers used quantitative methods to collect research data. The researcher also used a T-test as previously mentioned by the researcher. The purpose of collecting this data is to find relationships and become a benchmark between research object materials regarding the impact of using adaptive learning technology on increasing students' understanding of concepts. By collecting the answers of 15 respondents. Researchers also carried out further testing using SPSS software to ensure that respondents' responses were very accurate and reliable. Thus, researchers must be very careful when collecting processed data.

Table 1. Categories of Impact of Using Adaptive Learning Technology on Increasing Students' Understanding of Concepts

No	Gain category	Value interval
1	Agree	55-65%
2	Strongly Agree	>90%
3	Disagree	25%-50%
4	Not Agree	0-25%%
Total		100%

Figure 1. Data Collection and Analysis Flow

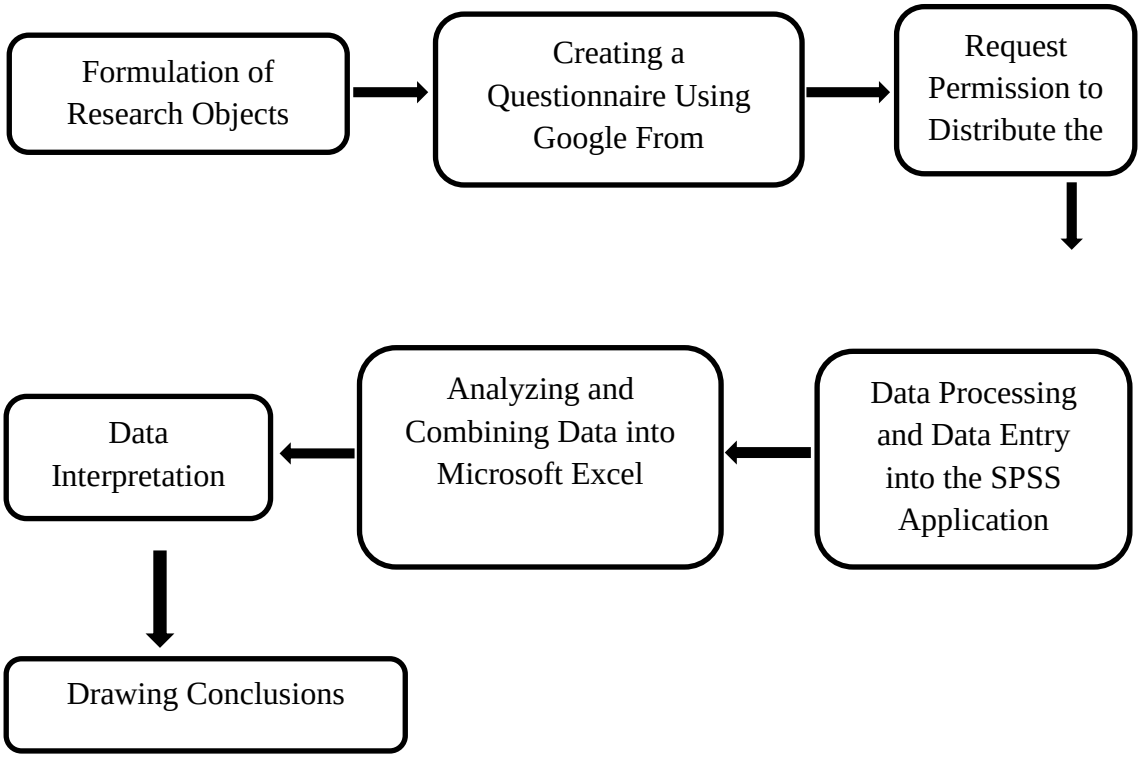

Figure 1 above shows how researchers collect and analyze research data. The results of data acquisition came from respondents' answers to the researcher's questions. Furthermore, in the quantitative research method, the researcher will also test again using the T-test which will be used to enter research data into the SPPS application. The number of questions asked by the researcher was 20 questions, where each question was divided into ten questions with different questions. Only after the questionnaire has been distributed can researchers formulate and draw conclusions from the research object.

RESULT AND DISCUSSION

Impact of Using Adaptive Learning Technology

The use of adaptive technology in the world of education plays a very important role in improving students' concepts. The use of adaptive learning technology has various positive and negative impacts that can be felt in the teaching and learning process. Adaptive technology can help increase the efficiency and effectiveness of the teaching and learning process. By using an algorithm which can analyze student needs and abilities in real-time. Adaptive learning systems can adjust materials, methods and task difficulty levels for each student. The existence of adaptive technology allows students to learn more effectively and is able to increase students' understanding of concepts.

Table 2. Summary of Percentage Results from Respondents' Answers

No.	Question	Strongly Agree	Agree	Disagree	Not Agree
1	Adaptive learning technology enables personalized learning according to individual needs and ability levels	55%	34%	6%	5%
2	The use of adaptive learning technology can accelerate students' understanding of the concepts being taught	45%	50%	5%	0%
3	Adaptive learning technology provides students with fast, specific feedback to help them correct mistakes	60%	30%	10%	0%
4	The use of adaptive learning technology increases student motivation to learn in a more interesting way	30%	45%	15%	10%
5	Adaptive learning technology can identify student weaknesses and provide additional material	65%	28%	7%	0%
6	The use of adaptive learning technology makes it easier for students to access learning material at any time	35%	20%	44%	1%

7	Adaptive learning technology allows students to learn in the style that best suits them	23%	60%	10%	7%
8	The use of adaptive learning technology expands students' access to a variety of diverse learning resources	30%	56%	12%	2%
9	Adaptive learning technology supports independent learning and student autonomy in the learning process	30%	50%	10%	10%
10	The use of adaptive learning technology can help students assimilate difficult concepts through varied approaches	70%	10%	10%	10%

Table 2 above shows the distribution of questionnaires that have been carried out by researchers. This questionnaire contains ten questions about the Impact of Implementing Game-Based Learning on Student Motivation and Engagement. In addition, during the distribution of the questionnaire, the researcher presented a percentage of each response from the respondents. Therefore, respondents can choose to answer the researcher's questions by providing options such as strongly agree, agree, disagree, or disagree. And it can also be seen from the first question asked by researchers regarding adaptive learning technology that allows personalized learning according to individual needs and ability levels, getting the highest score of 55% of strongly agree options.

The second question regarding the use of adaptive learning technology can accelerate students' understanding of the concepts being taught, obtained a percentage result of 50% agreeing. The third question about Adaptive learning technology provides fast and specific feedback to students to help them correct mistakes getting a score of 60% strongly agree. The fourth question regarding the use of adaptive learning technology increases students' motivation to learn in a more interesting way, getting a percentage gain of 45% agreeing. Next is the fifth question. Adaptive learning technology can identify student weaknesses and provide additional material. There are 65% of the strongly agree option. Furthermore, the sixth regarding the use of adaptive learning technology makes it easier for students to access learning material at any time, as many as 44% disagree.

The seventh question, that adaptive learning technology allows students to learn in the style that best suits them, got a percentage result of 60% choosing the agree option. In the eighth question regarding the use of adaptive learning technology to expand students' access to various learning resources, there was also an agree option of 56%. The ninth question regarding adaptive learning technology supporting independent learning and student autonomy in the learning process, obtained a percentage of 50% who agreed. For the last question regarding the use of adaptive learning technology that can help students assimilate difficult concepts through varied approaches, the percentage gain was 70% for the strongly agree option.

Table 3. Summary of Percentage Results from Respondents' Answers

No.	Question	Strongly Agree	Agree	Disagree	Not Agree
1	Adaptive learning technology facilitates interactive and participatory learning for students	10 %	88%	2%	0%
2	The use of adaptive learning technology allows students to practice repeatedly until they master the concepts	40%	40%	14%	6%
3	Adaptive learning technology provides a variety of learning methods to suit students' individual needs	25%	75%	0%	0%
4	The use of adaptive learning technology can reduce gaps in understanding between students with different ability levels	10%	35%	40%	15%
5	Adaptive learning technology allows for more accurate and relevant assessment of student progress	10%	85%	5%	0%
6	The use of adaptive learning technology provides access to a variety of learning formats, such as videos, simulations, and educational games	60%	20%	12%	8%

7	Adaptive learning technology helps students build a deeper and more integrated understanding of concepts	15%	40%	35%	10%
8	The use of adaptive learning technology can improve student academic outcomes in the long term	20%	75%	5%	0%
9	Adaptive learning technology allows teachers to monitor student progress in real-time and adjust their instruction accordingly	20%	70%	5%	5%
10	The use of adaptive learning technology increases the efficiency of students' study time, allowing them to learn more effectively.	20%	75%	5%	0%

In the statement in table 3 above, the researcher has also created ten questions. Which can be seen from the first question regarding adaptive learning technology facilitating interactive and participatory learning for students, getting a percentage result of 88% of agree options. Next, question number two regarding adaptive learning technology facilitates interactive and participatory learning for students, getting the same percentage score in the strongly agree and agree options of 40%. Question three Adaptive learning technology provides various learning methods that suit individual student needs, getting a percentage score of 75% agree.

The fourth question about the use of adaptive learning technology can reduce gaps in understanding between students with different ability levels, getting as much as 40% of the percentage score for the less agree option. The fifth question about adaptive learning technology allows a more accurate and relevant assessment of student progress, getting as many as 85% of the affirmative options. The sixth question regarding the use of adaptive learning technology providing access to various learning formats, such as videos, simulations and educational games, also received the same percentage of 50% for the strongly agree option.

Next, the seventh regarding adaptive learning technology helps students build a deeper and more integrated understanding of concepts, getting a percentage score of 40% agree. The eighth question regarding the use of adaptive learning technology can improve student academic outcomes in the long term, obtained a percentage of 75% agreeing. In question number nine, adaptive learning technology allows teachers to monitor student progress in real-time and adjust their instruction, the highest number of options agreed was also 70%. The last question about the use of adaptive learning

technology increases the efficiency of students' study time, allowing them to learn more effectively., got as much as 75% in the agree option.

Diagram 1

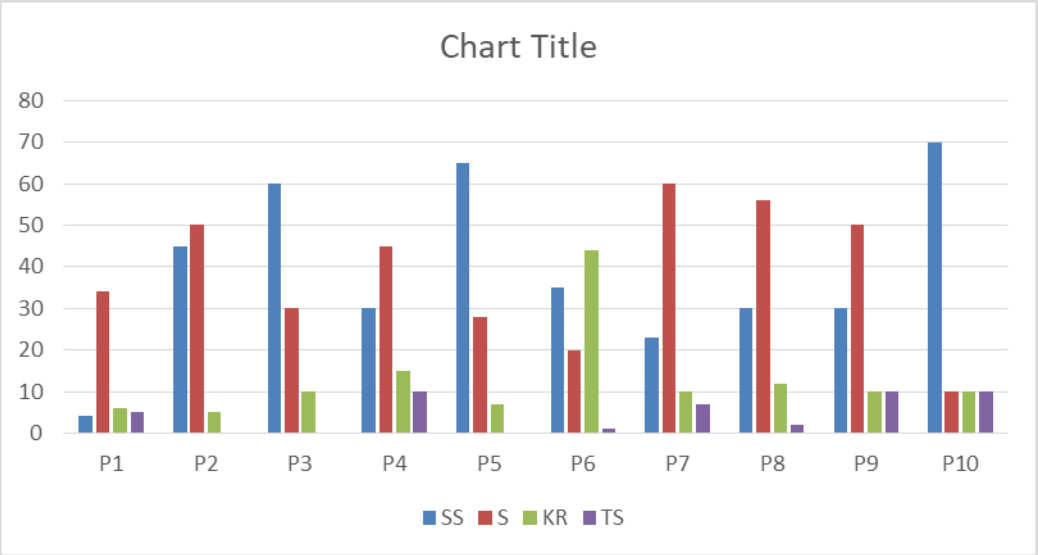

Diagram 2

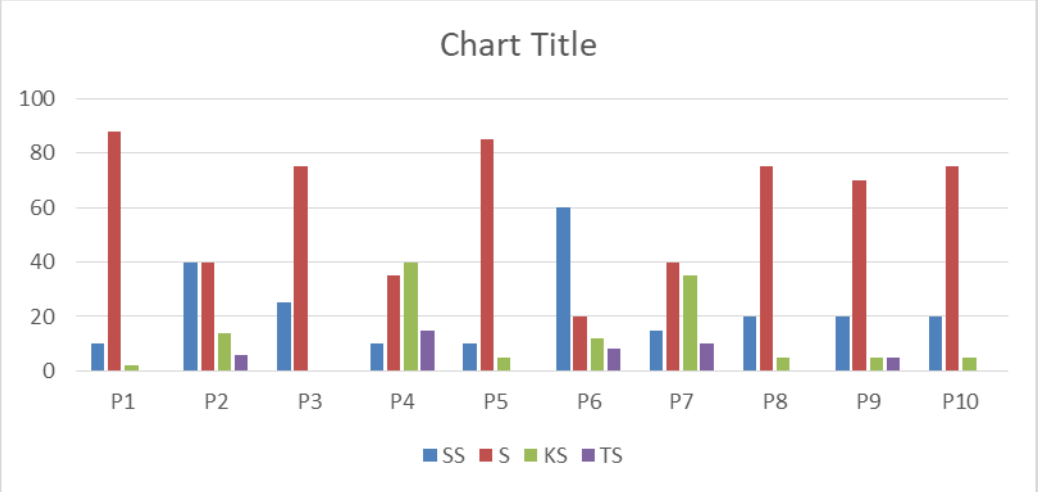

Table 3. T-test regarding the impact of using adaptive learning technology on increasing students' understanding of concepts

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE TEST	33.6500	20	19.37517	4.33242
	POST TEST	49.3000	20	23.01052	5.14531

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PRE TEST & POST TEST	20	-.752	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE TEST - POST TEST	-15.65000	39.69658	8.87643	-34.22857	2.92857	-1.763	19	.094

Based on the results of table 3 above, it is a T-test using the SPSS application. From the research results, the researcher can conclude that the T-test in the first output section explains the mean as the average. In the Pre Test the average number produced was 33.6500, while in the Post Test the result was 49.3000. Based on these results, it can be formulated that there are differences in the results of the respondents' answers. Next, in the Paired Samples Correlations section, you get a correlation of -.753, and the sign gain is .000. Next, in the Paired Samples Test section, we obtained a result of 39.69658 in the Std section. Deviation, while in the Std. Error Mean obtained a result of 8.87643. Based on these results, there is an impact of the use of adaptive learning technology on increasing students' understanding of concepts.

Table 4. T-test regarding the impact of using adaptive learning technology on increasing students' understanding of concepts

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE TEST	12.7368	19	12.69664	2.91281
	POST TEST	4.1579	19	4.71715	1.08219

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PRE TEST & POST TEST	19	.526	.021

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE TEST - POST TEST	8.57895	10.97632	2.51814	3.28853	13.86936	3.407	18	.003

Furthermore, in table 4, there are also the results of research using the T-test. It can be seen in the first output section that the Pre Test results were 12.7368, and the Post Test results were 4.1579. In the Paired Samples Correlations section, we obtained a correlation of .526, with a sign result of .021. Meanwhile, in the Paired Samples Test section, the results were 10.97632 in the Std section. Diviation, and Std. The mean error is 2.51814. Based on the results of this research, it can be seen between each question asked by the researcher regarding the Impact of Using Adaptive Learning Technology on Increasing Students' Understanding of Concepts.

The use of adaptive learning technology has shown significant improvements in the quality of learning and student learning outcomes (Parikh et al., 2019). This effect can be seen in several ways. This technology allows students to receive learning materials based on their performance, discover their strengths and weaknesses, and adapt the materials to their needs (Luijten et al., 2020). Thus, students can get a more efficient learning experience that suits their needs (Gao et al., 2019). Adaptive learning technology can improve the quality of learning by giving students access to resources that suit their needs and giving them control over their own learning process.

Students can learn dynamically and responsively in this way, and they can overcome difficulties posed by a diverse student population (Li et al., 2020). Research has shown the benefits of AI-based adaptive learning. Technology is expected to solve problems such as social inequality, access and quality of education (Liu et al., 2020). Adaptive learning technology allows students to access electronic-based learning applications and improve the achievement of learning goals. Students can control their own learning process and access resources that suit their needs increasing educational effectiveness and inclusion (He et al., 2018). So, technology can help children change the way they learn and have a bright future.

Increasing students' conceptual understanding has become the main focus in various research and implementation of learning strategies (HusniAti et al., 2020). Various studies have shown that the use of technology, learning models, and interactive media can improve students' understanding of concepts (Salian et al., 2022). Students can improve their ability to understand concepts through more dynamic and responsive learning activities. Increasing students' understanding of concepts can be achieved through various strategies and technologies used in the learning process (Díaz Cordero

& Badía Albanés, 2022). The use of interactive media, more active learning models, and technology can help improve students' understanding of concepts and improve their learning outcomes.

The use of adaptive learning technology has shown a positive impact on students' conceptual understanding (Alrawashdeh et al., 2024). This technology adapts learning materials and methods to meet students' unique needs, allowing them to learn in ways that best suit their learning styles and abilities (Reinmueller & Steinhauser, 2019). Real-time feedback helps students understand ideas faster and correct mistakes. This tailored approach can also increase students' desire, making them more engaged and motivated to learn (Atlı et al., 2019). By properly monitoring student progress, teachers can adjust learning and provide additional support when needed.

By having access to online lessons, students can customize the time and place they study (Khattak et al., 2018). Overall, students receive greater benefits from adaptive learning technology. By using machine learning algorithms and real-time analysis of student data, adaptive learning technology can adapt content, materials, and learning methods to meet students' individual learning needs (Chow et al., 2021). Adaptive learning technology allows teachers to track students' progress more accurately, identify their strengths and weaknesses, and provide appropriate feedback. Thus, this technology is very useful for education (Jiang et al., 2018).

CONCLUSION

The conclusion of this research shows that the use of adaptive learning technology has a significant impact in improving the quality of learning and student learning outcomes. This technology allows personalized learning to suit the needs and abilities of each student, so that they can learn more effectively and efficiently. With algorithms capable of analyzing student needs in real-time, materials, methods and task difficulty levels can be adjusted dynamically, providing a more responsive and individualized learning experience.

The results of the questionnaire and T-test conducted showed that the majority of respondents agreed with the benefits offered by adaptive learning technology. Most respondents acknowledged that this technology facilitates more interactive learning, provides fast and specific feedback, and accelerates understanding of the concepts being taught. Apart from that, this technology is also able to identify student weaknesses and provide appropriate additional material, thereby increasing student motivation and involvement in the learning process.

Overall, adaptive learning technology is proven to increase the effectiveness of students' learning and understanding of concepts. The use of this technology allows wider access to a variety of learning resources, supports independent learning, and increases educational inclusion. By utilizing adaptive learning technology, students can take control of their own learning process, ultimately helping them achieve better learning outcomes and preparing them for a bright future.

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