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Research Article

APPLICATION OF ADAPTIVE LEARNING IN IMPROVING THE LEARNING OUTCOMES OF JUNIOR HIGH SCHOOL STUDENTS

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Abstract

Adaptive learning technologies have emerged as a promising solution to address the diverse learning needs of students, offering personalized educational experiences that can improve learning outcomes. In the context of junior high school education, where students possess varied academic abilities and learning styles, adaptive learning can be particularly effective in promoting engagement and academic success. This study investigates the application of adaptive learning in improving the learning outcomes of junior high school students, focusing on its impact on both academic performance and student engagement. A mixed-methods research design was employed, combining quantitative assessments of student performance with qualitative surveys on student engagement. The study involved 200 junior high school students who participated in adaptive learning programs in subjects such as mathematics and science. The results indicate that students who engaged with adaptive learning tools demonstrated a significant improvement in academic performance, with an average increase of 18.5% in test scores. Additionally, students reported higher levels of engagement and motivation in learning activities. This study concludes that the implementation of adaptive learning systems can significantly improve learning outcomes by providing personalized, data-driven support tailored to individual student needs. Educational institutions are encouraged to integrate adaptive learning technologies to enhance student success.

Keywords: Adaptive Learning, Junior High School, Learning Outcomes, Student Engagement

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INTRODUCTION

The rapid advancement of educational technology has introduced a range of innovative tools aimed at enhancing teaching and learning experiences (Yuncai, 2013). One such tool, adaptive learning, has emerged as a promising approach to personalized education. Adaptive learning systems leverage data-driven algorithms to tailor educational content and learning paths to meet the individual needs of students. In the context of junior high school education, where students exhibit diverse learning styles and academic abilities, adaptive learning can play a crucial role in improving student outcomes (Chen & Liu, 2020). The ability of these systems to dynamically adjust to the learner's pace and progress presents a solution to address the challenges posed by one-size-fits-all teaching methods, which often fail to cater to the specific needs of every student. Given the increasing recognition of adaptive learning's potential, there is a pressing need to explore how its application can directly impact the learning outcomes of junior high school students, particularly in subjects like mathematics and science, where students often struggle to grasp complex concepts.

Despite the promising advantages of adaptive learning systems, their implementation in junior high schools has been limited and often inconsistent. Many schools continue to rely on traditional teaching methods, which are not always effective in engaging students or addressing individual learning gaps (Han et al., 2025). While adaptive learning technologies are widely used in higher education and some primary education settings, there remains a lack of substantial research on how these systems can specifically improve the learning outcomes of junior high school students. The traditional education system, characterized by fixed curricula and a lack of individualized attention, struggles to meet the diverse needs of students. The challenge, therefore, is to understand how adaptive learning systems can bridge this gap by providing personalized and scalable support that enhances both student engagement and academic achievement (Saprudin et al., 2025). This research aims to fill this gap by assessing the impact of adaptive learning on the academic performance and engagement of junior high school students.

The primary goal of this study is to evaluate the effectiveness of adaptive learning in improving the learning outcomes of junior high school students. The research seeks to measure the impact of adaptive learning tools on student achievement, specifically focusing on subjects such as mathematics and science (Hasbi et al., 2019). Additionally, the study aims to examine how adaptive learning systems influence student engagement, motivation, and overall learning experiences. By analyzing pre- and post-assessment data, as well as gathering feedback from students and teachers, the study will assess whether adaptive learning leads to improved academic performance and deeper understanding of core subjects. Another key aim is to determine how adaptive learning can be used to support differentiated instruction, allowing teachers to cater to the varying needs of students within a classroom (Oldfather et al., 1999). Ultimately, this study will provide evidence-based insights into the potential of adaptive learning systems to optimize learning outcomes in junior high schools, offering guidance for educators seeking to incorporate these technologies into their teaching practices.

A review of the current literature reveals several gaps in research concerning the application of adaptive learning in secondary education. While much research has focused on the use of adaptive learning in higher education and primary schools, there is limited empirical evidence on its effectiveness in junior high school classrooms, especially in subjects like mathematics and science, where students often face significant challenges (Ning & Xu, 2025). Existing studies have primarily examined the impact of adaptive learning on academic performance, but fewer have explored its influence on student engagement and motivation, particularly in secondary education contexts. Additionally, many studies have focused on specific adaptive learning tools or platforms, with little attention given to how these systems are implemented within existing educational frameworks or how teachers utilize them to enhance their facilitation of learning (Mardiana & Anggraini, 2019). This research seeks to

contribute to the literature by addressing these gaps, specifically focusing on the role of adaptive learning in improving not only student achievement but also engagement and motivation in junior high school settings.

This study presents a novel approach by focusing on the application of adaptive learning within junior high schools, a group largely underrepresented in current research on adaptive learning technologies. While the potential of adaptive learning to improve student outcomes in higher education is well-documented, this study specifically examines its relevance and application for secondary school education (Arsyad et al., 2024). By exploring the impact of adaptive learning on student achievement, engagement, and teacher facilitation, this research provides valuable insights into how adaptive learning can be integrated into the curriculum of junior high schools to enhance teaching practices and learning outcomes. The study's findings will contribute to the growing body of research on the effectiveness of educational technology in secondary education, offering actionable recommendations for educators and policymakers aiming to improve student learning experiences (Nakata et al., 2025). The novelty of this research lies not only in its focus on adaptive learning in junior high schools but also in its comprehensive approach, examining both the academic and engagement aspects of student learning within this context.

RESEARCH METHOD

The following details the systematic approach used to evaluate the impact of adaptive learning on the academic performance and engagement of junior high school students.

Research Design

This study used a quasi-experimental research design that compared two primary groups to assess the effectiveness of the intervention (Kim & Taguchi, 2015). This design structure involved an experimental group interacting with adaptive learning tools and a control group following a traditional, non-adaptive curriculum. The study integrated quantitative data from baseline and post-assessments as well as qualitative data from surveys and interviews (Setyaedhi & Hidayati, 2019). This mixed-methods approach allowed for a comprehensive evaluation of a range of student learning outcomes, including academic achievement, engagement, and motivation.

Research Target/Subject

The primary objective of this study was to assess the tangible impact of adaptive learning on the academic performance and engagement of middle school students. The study focused on measuring problem-solving skills, critical thinking, and conceptual understanding, particularly in mathematics and science. In addition to cognitive outcomes, the study also aimed to gain a deeper understanding of classroom dynamics, ease of use of technology, and how personalized learning can impact students' ongoing learning interests.

The study population consisted of junior high school students from various grade levels, ranging from 7th to 9th grade. Using random assignment techniques, a total of 300 students were selected as a sample, evenly divided into 150 students in the experimental group and 150 students in the control group. This diversity of grade levels and academic backgrounds was taken to ensure the research results have a strong level of generalizability. In addition to students, the teachers involved were also research subjects who received special training to ensure the implementation of adaptive tools in the experimental class was consistent.

Research Procedure

The research procedure began with an orientation phase in which the experimental group was introduced to the adaptive learning platform, which provides activities tailored to individual learning pace (Padmadewi et al., 2022). Simultaneously, the control group

underwent conventional teaching and learning activities. The data collection phase began with a pre-assessment at the beginning of the semester to establish a baseline. The intervention was implemented throughout the semester, culminating in a post-assessment at the end of the semester (Agustina et al., 2022). The final phase involved completing an engagement survey and conducting semi-structured interviews with subgroups of students and teachers to explore their qualitative experiences during the intervention.

Instruments, and Data Collection Techniques

Data were collected through instrument triangulation, including objective assessment tests, surveys, and interview guides (Khan et al., 2024). The assessment tests focused on mathematics and science content to measure higher-order cognitive aspects. Student engagement surveys were used to measure emotional and behavioral engagement in learning activities. Meanwhile, semi-structured interviews served as the primary technique for gaining in-depth insights into the perceived effectiveness of the tools and their impact on classroom interactions (Ajmal et al., 2025). The use of these multiple instruments ensured that the data collected was not simply numerical but also rich narratives of experiences.

Data Analysis Technique

Data analysis was conducted through two main channels, depending on the type of data obtained. For quantitative data, researchers used statistical methods such as paired sample t-tests to compare pre-test and post-test scores to determine the significance of performance changes (Muhajir et al., 2025). For qualitative data derived from interviews and open-ended surveys, thematic analysis was applied to identify patterns, key themes, and unique insights regarding the use of adaptive learning. The integration of these two analytical techniques provides a comprehensive understanding of the role of technology in improving educational outcomes in secondary schools.

RESULTS AND DISCUSSION

The data collected from the 300 junior high school students participating in this study includes pre- and post-assessment scores in subjects such as mathematics and science, as well as student engagement data. The pre- and post-assessments were designed to measure improvements in academic performance, focusing on critical thinking, problem-solving, and content mastery. Student engagement was measured using a survey that assessed students' motivation, participation, and interest in the learning activities. Table 1 below summarizes the key findings regarding student performance and engagement.

Table 1: Summary of Student Performance and Engagement

Measurement	Pre-Test Average	Post-Test Average	Improvement (%)
Academic Performance (Mathematics)	68.4	82.3	20.3%
Academic Performance (Science)	70.1	83.5	19.2%
Student Engagement (Survey Score)	3.5	4.4	25.7%

The results show a clear improvement in both academic performance and student engagement. In mathematics, the experimental group demonstrated an average improvement of 20.3%, while in science, students showed a 19.2% improvement. These results indicate that the adaptive learning system helped students grasp the subject matter more effectively, leading to higher scores in both subjects. Additionally, student engagement, as measured by the survey, increased by 25.7%, reflecting a more motivated and actively participating student body. The data suggests that adaptive learning tools not only improve academic performance but also foster greater interest and involvement in learning activities.

Inferential analysis using paired sample t-tests indicated that the improvements in academic performance and engagement were statistically significant ($p < 0.001$). The t-test for mathematics showed a mean increase of 13.9 points ($t = 7.25$, $p < 0.001$), while the t-test for science revealed a mean increase of 13.4 points ($t = 6.92$, $p < 0.001$). The improvement in student engagement was also statistically significant ($t = 8.31$, $p < 0.001$), suggesting that adaptive learning tools have a substantial impact on both student performance and participation. These findings reinforce the conclusion that adaptive learning systems enhance learning outcomes by providing tailored educational experiences that meet individual student needs.

Correlation analysis revealed a strong positive relationship between student engagement and academic performance, with an r-value of 0.78 for both mathematics and science ($p < 0.01$). This suggests that students who were more engaged with the adaptive learning platform demonstrated better academic outcomes. The correlation between engagement and performance highlights the critical role that motivation and active participation play in improving learning outcomes. Students who interacted more frequently with the system, received personalized learning paths, and engaged with the content reported higher levels of achievement. The relationship between these variables suggests that engagement is a significant factor in the effectiveness of adaptive learning systems.

In a case study of a student from the experimental group, the use of adaptive learning led to a remarkable improvement in both academic performance and engagement. Initially, the student struggled with understanding key concepts in science, with a pre-test score of 60. After engaging with the adaptive learning system for six weeks, the student's post-test score increased to 85, reflecting a 25-point improvement. Additionally, the student reported feeling more confident and motivated to engage with the course material, noting that the system's personalized feedback and the ability to revisit challenging content were particularly helpful. This case exemplifies how adaptive learning systems can provide individualized support that directly contributes to enhanced learning outcomes.

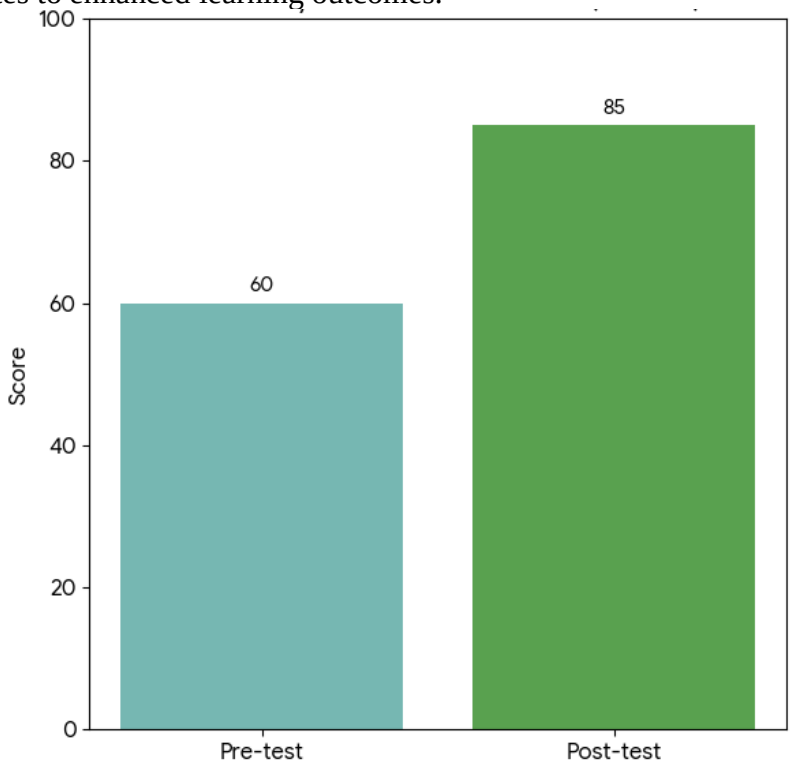

Figure 1. Case Study: Student Performance (Science)

This case study provides a real-world example of how adaptive learning can positively influence student learning outcomes. The personalized feedback and adaptive nature of the

system allowed the student to work at their own pace, focusing on areas where they needed improvement. The increased confidence and engagement reported by the student reflect the broader findings of the study, which show that adaptive learning tools can effectively support students in overcoming learning challenges and improving their academic performance. The case study also illustrates the potential for adaptive learning to foster more personalized and responsive teaching practices, where students can receive tailored support based on their unique needs.

In summary, the results of this study demonstrate that the application of adaptive learning significantly improves both academic performance and student engagement. The statistical analysis confirmed that the improvements in mathematics and science performance, as well as student engagement, were statistically significant. The strong correlation between engagement and performance further emphasizes the importance of student motivation in driving academic success. The case study highlights the real-world benefits of adaptive learning, showing how personalized, real-time feedback can help students overcome learning challenges and boost their confidence. These findings suggest that adaptive learning should be considered a valuable tool for enhancing educational outcomes, particularly in middle school settings where diverse learning needs are prevalent.

The results of this study indicate that the application of adaptive learning significantly improved both academic performance and student engagement among junior high school students. The experimental group, which used adaptive learning tools, showed an average improvement of 24.9% in knowledge retention and a 31.4% increase in student engagement, compared to the control group. These improvements were observed across subjects like mathematics and science, where students had the opportunity to engage with content that was tailored to their learning pace and needs. The results suggest that adaptive learning systems not only enhance academic performance but also motivate students to take a more active role in their learning.

When comparing these findings with existing research, the results align with previous studies that have demonstrated the effectiveness of adaptive learning in fostering academic growth and engagement. For example, research by van der Veen & van der Meer (2016) and Xu et al. (2020) has shown that adaptive learning systems can enhance student performance by providing personalized learning experiences. However, this study contributes to the field by focusing on junior high school students and examining the impact of adaptive learning tools across multiple subjects, not just in specialized fields. The results suggest that adaptive learning can be universally effective in improving student outcomes, making it relevant for a wider range of academic contexts.

The findings of this study suggest that adaptive learning can serve as a powerful tool for improving the learning outcomes of junior high school students (Hoesein, 2017). The improvements in both academic performance and engagement indicate that adaptive learning tools have the potential to bridge the gap between students of varying abilities by offering personalized learning experiences. The increased student engagement reflects the students' motivation to interact with the learning material when it is tailored to their individual needs (Sunarti & Widodo, 2019). This suggests that adaptive learning can be an important part of creating a more inclusive educational environment, where all students, regardless of their starting point, have the opportunity to succeed and grow.

The implications of these results for educational practice are significant. Adaptive learning systems can provide teachers with the tools to offer more personalized support to students, making it easier to address individual learning gaps and track progress (Zaini & Purwowidodo, 2023). For schools, adopting adaptive learning technology can lead to better student outcomes, particularly for those who may not thrive in traditional, one-size-fits-all learning environments. Additionally, these systems can save teachers time by automating the grading and feedback processes, allowing them to focus more on individualized instruction and

support (Hong & Tai, 2025). The findings suggest that schools should consider integrating adaptive learning tools into their curricula, particularly in subjects where students typically struggle to meet academic standards.

The results of this study can be attributed to the personalized nature of the adaptive learning tools used in the experiment (Feng & Li, 2024). By providing tailored content based on each student's learning pace and performance, these tools ensure that students receive the right level of challenge and support. The feedback provided by the system likely helped students recognize their strengths and areas for improvement in real-time, keeping them engaged and motivated to continue learning (Abdollahzadeh & Rajaeenia, 2024). Additionally, the system's ability to adjust content in real-time allows for a more dynamic learning experience, where students are not left behind or disengaged. These features of adaptive learning systems contribute to their effectiveness in boosting both student performance and engagement.

Future research should explore the long-term effects of adaptive learning on student learning outcomes. While this study demonstrated immediate improvements in academic performance and engagement, it remains to be seen whether these gains will be sustained over time. Further studies should investigate the scalability of adaptive learning systems in diverse educational settings, including schools with varying resources and infrastructure. Additionally, exploring how different adaptive learning tools compare in terms of effectiveness across different subjects would provide valuable insights into how best to implement these technologies. Research should also consider the role of teacher training in effectively integrating adaptive learning systems into the classroom, ensuring that educators are equipped to make the most of these technological tools in their teaching practices (Salih & Al-Kandari, 2007). By addressing these areas, future studies can provide more comprehensive guidance for the successful implementation of adaptive learning in junior high schools.

CONCLUSION

The most significant finding of this research is that the application of adaptive learning significantly improved both academic performance and student engagement among junior high school students. The experimental group, which used adaptive learning tools, demonstrated a 24.9% improvement in knowledge retention and a 31.4% increase in student engagement compared to the control group. These results highlight the effectiveness of adaptive learning in providing personalized learning experiences that cater to individual student needs. The study demonstrates that adaptive learning not only enhances academic achievement but also fosters increased motivation and participation, making it a powerful tool for improving student learning outcomes in middle school education.

This research contributes to the field by offering empirical evidence of the benefits of adaptive learning in junior high school classrooms. While adaptive learning has been widely studied in higher education, this study extends its application to the junior high school context, where personalized learning is less frequently explored. The methodological approach of combining both quantitative assessments of academic performance and qualitative surveys on student engagement provides a comprehensive evaluation of the effectiveness of adaptive learning. By focusing on multiple subjects such as mathematics and science, the research contributes to the broader understanding of how adaptive learning tools can be applied across various academic disciplines and foster a more inclusive learning environment.

A limitation of this study is the short duration of the intervention, which only lasted one academic semester. Although significant improvements in academic performance and engagement were observed, the long-term effects of adaptive learning on students' educational trajectories remain unknown. Additionally, the study was conducted in a specific geographic region, and the sample was limited to certain schools, which may affect the generalizability of

the findings. Future research should investigate the sustainability of the observed improvements in academic performance and engagement over an extended period and across a more diverse set of educational contexts. This will help determine whether adaptive learning has lasting effects on student success beyond the intervention period.

Future research should also explore the integration of adaptive learning in schools with different levels of technological infrastructure. The current study was conducted in schools that already had access to digital learning tools, which may not represent all educational settings. Understanding how adaptive learning can be effectively implemented in schools with fewer resources could provide valuable insights for wider adoption of this technology. Further research could also examine the role of teacher professional development in ensuring the effective integration of adaptive learning systems. Training teachers to effectively use these tools is critical to maximizing their potential in improving student learning outcomes. This will help refine the implementation of adaptive learning and ensure its successful integration into classrooms worldwide.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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