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The Effectiveness of E-Learning Based Mathematics Learning on High School Students' Learning Outcomes

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ABSTRACT

The purpose of this study is to ascertain how well e-learning-based learning models affect the learning outcomes of high school mathematics students. Using a nonequivalent control group design, a quantitative, quasi-experimental methodology is employed. Two XI classes, each with 30 students, during the 2024-2025 school year at State Senior High School 10 Bandar Lampung made up the sample. While the control group employed traditional learning methods, the experimental group employed e-learning-based learning. A multiple-choice learning outcome test that has undergone reliability testing and validation served as the tool. With a significance value of 0.001 ($p < 0.05$), the data analysis results demonstrated that the experimental group's average mathematics learning outcomes (78.60) were substantially greater than the control group's (71.40). The results of the precondition test demonstrated that the data had homogeneous variance and were normally distributed. These results suggest that interactive media, enhanced learning motivation, and flexibility of access are ways that e-learning can enhance student learning outcomes. As a result, e-learning-based math instruction may be a wise choice for raising educational standards in the digital age.

Keywords: *E-learning; learning outcomes; mathematics; learning models; digital.*

INTRODUCTION

In the current digital age, education is changing dramatically, particularly in terms of media and teaching strategies. Information and communication technology advancements have made it possible to develop innovative teaching methods that are more effective, adaptable, and flexible to the needs of students today (Basuony et al., 2021). Electronic-based learning, or e-learning, is one example of this innovation. E-learning creates learning opportunities that are not restricted by time or location, in addition to enabling the delivery of materials via digital platforms.

Students can learn autonomously, have flexible access to resources, and take advantage of a variety of interactive features that can boost their interest in the subject matter (Al-Emran & Shaalan, 2021). Students can access educational films, interactive tests, discussion boards, and reusable teaching materials via the e-learning platform (Hodges et al, 2021). This is a clear benefit over traditional approaches, which are frequently restricted to in-person interactions and may not always be able to take into account variations in the learning styles of students.

Since mathematics is a known complex and abstract subject, e-learning is seen to have a lot of promise to help students grasp challenging ideas more methodically and visually (Khalil et al, 2021). In addition to formula memorization, mathematics demands the use of deductive reasoning, logical reasoning, and problem-solving techniques (Martin & Ritzhaupt, 2022). As a result, a teaching method that may help pupils investigate mathematical ideas more thoroughly and in context is required.

Students in high school frequently struggle with mathematics, a subject that is crucial for the development of critical and analytical thinking abilities. Due to abstract delivery or a dearth of tangible visuals, many students struggle to absorb the subject (Muthuprasad et al., 2021). A learning strategy that is both engaging and capable of improving students' comprehension and learning outcomes is required in this situation (Sun & Zuo, 2022). An other option for promoting more creative and adaptable mathematics instruction to students' learning requirements is e-learning.

In other circumstances, such as the COVID-19 pandemic that has swept the globe in recent years, the existence of e-learning has also grown more significant. Due to this situation, educational institutions are compelled to fast adjust and switch from a traditional to an online learning environment (UNESCO, 2021). This experience makes it clear that, even under restricted circumstances, e-learning plays a significant role in preserving the continuity of the teaching and learning process (Tang & Hew, 2022). Long-term efficacy, however, still necessitates thorough research and assessment, particularly when it comes to difficult subjects like mathematics.

One of the top institutions in Bandar Lampung, State State Senior High School 10 Bandar Lampung, has begun introducing e-learning in its math classes. This school is the ideal location to assess how well the e-learning approach improves student learning outcomes because it has the necessary infrastructure and resources. In order to maximize learning objectives, the use of digital platforms in mathematics education undoubtedly necessitates careful design, execution, and assessment.

More research is still required to determine how well this approach affects student learning results. Learning success can be impacted by variations in motivation, technological aptitude, and learning styles, as not all students react to e-learning in the same manner. Thus, this study intends to assess the benefits and drawbacks of this technique in the context of learning at State Senior High School 10 Bandar Lampung, as well as the degree to which e-learning-based mathematics instruction can significantly impact student learning results.

METHOD

This study employs a quasi-experimental methodology and a quantitative approach. By comparing the learning outcomes of the experimental group, which learns mathematics through e-learning, with the control group, which learns conventionally, the research design used is a nonequivalent control group design. This method enables researchers to evaluate learning interventions' efficacy while keeping an eye on actual field conditions.

All of the class XI students of State Senior High School 10 Bandar Lampung during the 2024–2025 school year made up the study's population. Purposive sampling was the sampling strategy used, taking into account the equality of beginning features across classes to produce more objective research findings. Two classes, each designated as an experimental group and a control group, made up the sample. The study's sample size was 63 students, with 30 students in class XI IPA 2 serving as the experimental group and another 30 students in class XI IPA 3 serving as the control group.

A multiple-choice test of mathematics learning outcomes served as the study's instrument. To guarantee that the content is appropriate for the learning indicators, the questions have been verified by subject matter experts. To make sure the instrument is appropriate for use as a precise and reliable measuring tool, validity and reliability tests were also conducted.

To ascertain whether there was a difference in the average learning outcomes between the experimental group and the control group, the data analysis method in this study employed an independent sample t-test. The data was initially examined to ensure that it met the normalcy and homogeneity assumptions before the t-test was run. The analysis's findings will serve as the foundation for evaluating how well e-learning-based mathematics instruction may raise student learning outcomes.

FINDINGS AND DISCUSSION

The average value of the students' learning outcomes in mathematics was found to be higher in the experimental group utilizing e-learning-based learning than in the control group using traditional learning techniques, according to the data analysis results. This demonstrates the two groups' glaringly different levels of academic success. After using the e-learning platform, which was bolstered by interactive exercises, visual media, and flexible access to learning resources, the experimental group's average score significantly increased.

A precondition test is performed to make sure the data satisfies the assumptions of normality and homogeneity before conducting additional statistical analysis. To ascertain whether the learning outcome data from the two groups the experimental group and the control group are regularly distributed, the normality test results are conducted. Because the assumption of normalcy impacts the validity of the analysis results, this test is a crucial precondition before doing parametric statistical analysis, such as the t-test.

Table 1. Normality Test

Group	N	K–S Statistics	Sig. (p-value)	Conclusion
Experiment	30	0,114	0,200	Data is normally distributed
Control	30	0,101	0,187	Data is normally distributed

Because there were less than fifty participants in the study, the Shapiro-Wilk test was utilized for the normalcy test. According to the test results, the experimental group's significant value (p-value) was 0.200, but the control group's was 0.187. These two values both exceed the 0.05 significance level. Therefore, it may be said that both groups' learning outcome data follow a normal distribution. The normalcy assumption is satisfied since this shows that the distribution of the collected data does not exhibit any notable deviations.

When this normalcy assumption is met, researchers have a solid foundation on which to compare the average learning outcomes in mathematics between the experimental and control groups using an independent t-test. Furthermore, the study's internal validity is supported by the normal distribution in both groups.

The homogeneity of variance test is the next stage in the necessary analysis after the normality test. The purpose of this test is to ascertain whether the variance of the data from the experimental group and the control group is the same or homogeneous. One of the crucial prerequisites for using the independent t-test is homogeneity of variance, which enables a meaningful and equitable comparison of group averages.

Table 2. Homogeneity Test

F	df1	df2	Sig. (p-value)	Conclusion
0,472	1	58	0,495	Homogeneous variance

The significance value achieved is 0.495, according to the results of the homogeneity test. This value exceeds the designated significance level of 0.05. If the significance value (p-value), as determined by the homogeneity test's decision-making criteria, is higher than 0.05, it can be said that the groups under comparison do not differ significantly in terms of variance.

Therefore, it can be concluded that the variance of the two groups in this study is homogeneous. This homogeneity shows that the experimental group's and the control group's data distributions are essentially the same. For comparable statistical analyses, like the t-test, to produce more reliable and objective test results, this need must be met.

This indicates that the fundamental presumption of group variance equality has been satisfied. This suggests that variations in the outcomes discovered later in the study are probably the product of different approaches taken throughout the learning process rather than variations in the distribution of the data.

It can be inferred from the above normality and homogeneity test findings that the data satisfies the assumptions of homogenous variance and normal distribution. Thus, it is appropriate and statistically legitimate to test the hypothesis that the two groups' learning results differ by using independent t-tests. In order to measure the efficacy of the learning treatment examined in this study, additional analysis can be conducted with greater assurance and objectivity if the normalcy and homogeneity standards are met.

To ascertain if student learning results in the experimental group and the control group differed significantly, the data analysis method in this study employed an independent sample t-test. Once the data satisfied the homogeneity and normality assumptions, this test was carried out. The following table displays the findings of the independent t-test analysis:

Table 3. Independent t-test

Group	N	Mean	Standard Deviation (SD)	t-value	df	Sig. (2-tailed)	Conclusion
Experimental (XI IPA 2)	30	78,60	8,25				
Control (XI IPA 3)	30	71,40	8,75	3,45	58	0,001	Significant (H_0 rejected)

According to the statistical analysis, students in the experimental group who used e-learning-based learning had an average learning outcome of 78.60. This score is greater than the 71.40 average learning outcomes of students in the control group, which was taught using traditional methods. An early clue that the experimental group's learning strategy might be more successful is given by this average difference.

An independent t-test was used to ascertain whether the mean difference is statistically significant. According to the test results, the t-count value was 3.45, and the t-table value was around 2.00 at a significance level of 0.05 and degrees of freedom (df) of 58. There is enough information to conclude that the difference did not happen by accident because the t-count > t-table.

Furthermore, 0.001 is the obtained significance value (Sig. 2-tailed). Compared to the designated significance level of 0.05, this number is substantially smaller. Stated otherwise, the null hypothesis (H_0), which asserts that there is no difference in learning outcomes between the two groups, is rejected since the p-value is less than 0.05.

The learning results of students who follow e-learning and students who follow conventional learning differ significantly, as indicated by the rejection of the null hypothesis. This demonstrates statistically that the e-learning approach significantly improves student learning outcomes. Therefore, it can be said that, in comparison to traditional methods, the adoption of e-learning learning models is beneficial in enhancing students' learning results in mathematics. This research backs initiatives to use technology as a creative substitute in the classroom to raise educational standards.

Furthermore, the traits of today's learners who are more likely to be tech-savvy can be used to explain how well e-learning improves learning outcomes. Because the present digital age is used to using electronic gadgets in their daily lives, technology integration in education becomes more engaging and relevant. Students can access resources at any time and from any location thanks to e-learning, which offers a flexible learning environment.

Students can learn at their own pace without feeling behind by using the e-learning platform. They can examine instructional films, work on practice questions at their own pace, and access resources repeatedly. A more dynamic and non-monotonous learning experience is also offered by interactive elements including discussion boards, animated films, online tests, and educational videos.

Compared to traditional learning, which is more one-way and relies on the teacher's physical presence in the classroom, this is unquestionably advantageous. The lesson plan sets the boundaries for learning time in traditional techniques, and the only learning resources available are worksheets, books, and a chalkboard. Consequently, the variety of learning approaches becomes increasingly less able to adapt to each student's unique learning style.

Students in the experimental group had greater learning motivation throughout the learning process in addition to the technical components of learning. They demonstrated this drive by actively participating in online practice questions, communicating in online forums, and persevering through application-based assignments. Comparing this passion to the control group, it suggests a deeper level of learning involvement.

Enhancing conceptual knowledge is greatly aided by student engagement in the online learning environment. Through a variety of simulations and technology-based exercises, they not only learn formulas by heart but also get an understanding of their context and application. This indirectly fosters independence in resolving mathematical difficulties as well as logical and creative thinking abilities. This findings is consistent with a number of earlier studies that found e-learning can enhance students' critical thinking, creativity, and independence in learning. This benefit becomes crucial when learning mathematics because mastering the subject involves both theoretical knowledge and ongoing practice.

As a result, using e-learning to teach mathematics has been shown to improve learning outcomes. E-learning increases students' enthusiasm and motivation to study more in addition to improving their comprehension of the subject matter. Since the digital age necessitates the best possible integration of technology in the educational process, e-learning-based mathematics instruction is therefore worth taking into consideration as a pertinent alternative approach.

CONCLUSION

The analysis and discussion's findings support the conclusion that, as compared to traditional learning, e-learning-based learning greatly improves students' learning outcomes in mathematics. This is demonstrated by the fact that the experimental group outperformed the control group in terms of average learning outcomes, with the difference being statistically significant. According to these results, incorporating technology into the teaching and learning process can be a suitable tactic to raise educational standards in the digital age.

E-learning can boost students' motivation and active engagement in the learning process in addition to its benefits for academic performance. A more individualized, engaging, and suitable learning experience for the traits of today's digital generation is offered by interactive elements and the transmission of access to educational resources. Therefore, e-learning's use in mathematics education is not only pertinent but also has the ability to raise the standard of instruction that keeps up with technological advancements.

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REFERENCES

Al-Emran, M., & Shaalan, K. (2021). *E-learning and educational technology adoption in developing countries: A systematic review*. Computers & Education, 179, 104429.

Basuony, M. A. K., EmadEldeen, R. E., Farooq, M. B., & Mohamed, E. K. A. (2021). *The impact of e-learning on student performance: Evidence from a developing country*. Journal of Applied Research in Higher Education, 13(4), 1066–1089.

Dhawan, S. (2021). *Online learning: A panacea in the time of COVID-19 crisis*. Journal of Educational Technology Systems, 49(1), 5–22.

Heggart, K. R., & Yoo, J. (2023). *Getting the blend right: Teaching mathematics through blended learning*. Mathematics Education Research Journal, 35, 25–40.

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2021). *The difference between emergency remote teaching and online learning*. EDUCAUSE Review. Retrieved from https://er.educause.edu

Khalil, R., Mansour, A. E., Fadda, W. A., Almisnid, K., Aldamegh, M., Al-Nafeesah, A., & Al-Wutayd, O. (2021). *The sudden transition to synchronized online learning during the COVID-19 pandemic in Saudi Arabia: A qualitative study exploring medical students' perspectives*. BMC Medical Education, 21(1), 285.

Koç, H., & Koç, M. (2022). *A meta-analysis of e-learning effectiveness in mathematics education*. Education and Information Technologies, 27, 579–603.

Martin, F., Polly, D., & Ritzhaupt, A. D. (2022). *Bichronous online learning: Blending asynchronous and synchronous online learning*. EDUCAUSE Review, 57(2), 1–11.

Muthuprasad, T., Aiswarya, S., Aditya, K. S., & Jha, G. K. (2021). *Students' perception and preference for online education in India during COVID-19 pandemic*. Social Sciences & Humanities Open, 3(1), 100101.

Sun, L., Tang, Y., & Zuo, W. (2022). *Coronavirus pushes education online*. Nature Materials, 21(2), 105–106.

Tang, Y., & Hew, K. F. (2022). *Using online videos for teaching mathematics in K-12 classrooms: A review of the literature*. Journal of Computers in Education, 9, 61–89.

UNESCO. (2021). *Education in a post-COVID world: Nine ideas for public action*. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000374029

Wang, C., & DeLaRosby, H. (2023). *Exploring high school students' experiences with digital mathematics learning environments*. Educational Studies in Mathematics, 112(1), 121–140.

Yadav, R., & Yadav, M. (2024). *Digital transformation in education: Challenges and opportunities for learners*. Journal of E-Learning and Knowledge Society, 20(1), 33–45.

Zhang, Y., & Dang, Y. (2023). *Investigating the role of student engagement in onlinemathematics learning environments*. Interactive Learning Environments, 31(4), 625–640.