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Comparison of Student Learning Outcomes Using Digital and Conventional Learning Media in Senior High School

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Abstract

The integration of digital technology in education has become a strategic necessity to improve student learning outcomes in the digital era. This study aimed to compare the effectiveness of digital and conventional learning media in enhancing student achievement among seventh-grade junior high school students. A quasi-experimental research design with a pretest-posttest control group approach was employed. Sixty students were purposively selected and divided equally into two groups: an experimental group and a control group. Data were collected using a multiple-choice test to measure learning outcomes and analyzed using paired sample t-tests and independent sample t-tests to determine within-group and between-group differences. The results showed that the group taught using digital learning media achieved significantly higher posttest scores (M = 84.7) compared to the group taught using conventional methods (M = 70.2). In contrast, pretest scores between the two groups were nearly equal. The statistical analysis confirmed that digital media had a more substantial effect on improving learning outcomes than conventional media. These findings support multimedia learning theories and highlight the importance of interactive and student-centred digital environments. In conclusion, digital learning media offer significant advantages in promoting students' academic achievement and should be increasingly integrated into classroom instruction. Future research should explore its long-term effectiveness and adaptability in different contexts. Educational institutions are encouraged to invest in teacher training and infrastructure to support technology-based learning.

Keywords: Digital media in education, learning achievement, instructional technology, learning outcomes, static fluid.

INTRODUCTION

In the era of digital transformation, the use of technology in education has become increasingly significant. Learning media—both digital and conventional—play a crucial role in facilitating knowledge acquisition and improving student performance. Digital media, including educational apps, online simulations, and multimedia content, have demonstrated the potential to enhance students' motivation and engagement (Mayer, 2021). Conversely, conventional learning tools, such as textbooks, printed worksheets, and face-to-face instruction, are still valued for their simplicity and effectiveness in fostering deep understanding and retention (Singer & Alexander, 2017). Understanding the strengths and limitations of each medium is essential, particularly at the junior high school level, where students begin to develop independent learning skills and critical thinking.

The relationship between the type of learning media and student outcomes has attracted scholarly attention. Several studies indicate that students' digital literacy has a significant impact on their ability to benefit from technology-enhanced instruction. For example, a comparative study in Indonesia and The Gambia found that students with higher digital literacy achieved better outcomes in science classes (Ismail et al., 2023). Similarly, Li et al. (2022) reported that digital literacy enhances learning satisfaction and academic performance in online learning environments among middle school students in China. However, the effectiveness of media also depends on pedagogical strategies, content design, and the alignment between technology and curriculum objectives (Zhang & Zhou, 2020). Hence, exploring how different media types influence student achievement remains a critical issue.

Despite the growing adoption of digital media in schools, a debate persists about their superiority over conventional approaches. Some researchers argue that merely introducing technology without proper instructional planning may not result in meaningful learning gains (Tamim et al., 2015). Others emphasize that students often perform better when reading printed texts compared to digital texts, especially in terms of comprehension and recall (Singer & Alexander, 2017). Moreover, challenges such as teacher readiness, digital infrastructure, and student access further complicate the success of digital learning in real-world school settings (Raihan et al., 2022). These conflicting findings highlight the need for empirical studies that directly compare digital and conventional media within the same learning environment.

This study aims to address the research gap by comparing student learning outcomes using digital and conventional media in junior high school settings. Previous works—such as those by Ismail et al. (2023), Li et al.

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(2022), and Mayer (2021)—have either focused on the impact of digital media alone or examined general attitudes toward technology, without a direct comparison of performance between digital and non-digital settings. The novelty of this research lies in its dual comparison design and inclusion of digital literacy as a moderating factor. It contributes to educational practice by providing evidence-based recommendations for media use in junior high classrooms. Specifically, this study aims to (1) compare student learning outcomes between digital and conventional media users, (2) assess the role of digital literacy in student achievement, and (3) analyze the interaction effect between media type and literacy level on learning performance.

MATERIALS AND METHODS

Time and Place

This research was conducted at SMAN Negeri 1 Labuapi, located in West Lombok Regency, Indonesia, during the even semester of the 2024/2025 academic year, specifically from March to May 2025. The school was selected based on its accessibility, availability of digital learning facilities, and willingness to support experimental educational research. The selection of this setting aimed to provide a representative context of junior high school education in a semi-urban Indonesian area, where both digital and conventional learning media are utilized in different classroom settings.

Research Design

This study employed a quasi-experimental research design, utilizing a pretest-posttest control group approach. This design was chosen because it allows the researcher to evaluate the effect of a treatment or intervention by comparing changes in learning outcomes before and after the intervention, while still maintaining control over the group assignments. Although the groups were not randomly assigned, the design is appropriate for educational settings where ethical or practical constraints make randomization difficult (Creswell & Creswell, 2018). Furthermore, this design enables researchers to draw causal inferences with greater confidence than purely observational studies (Fraenkel, Wallen, & Hyun, 2019).

Population and Sample

The population of this study consisted of all seventh-grade students enrolled at SMA Negeri 1 Labuapi in the 2024/2025 academic year. A total sample of 60 students was selected using a purposive sampling technique, divided equally into two groups: 30 students in the experimental group and 30 students in the control group. The criteria for inclusion included similar prior academic performance, as documented in school records, and consistent access to either digital or conventional learning environments, depending on the group assignment. The experimental group received instruction using digital learning media, such as interactive presentations, videos, and online quizzes. In contrast, the control group was taught using traditional media, such as textbooks, worksheets, and teacher explanations on the board. Purposive sampling was chosen because it enables researchers to select participants who best fit the research objectives, particularly when comparing two instructional approaches under controlled conditions (Etikan, Musa, & Alkassim, 2016).

This study focused on two primary variables: (1) The independent variable was the type of learning media, with two levels: digital and conventional. (2) The dependent variable was the students' learning outcomes, measured through a validated multiple-choice test covering the learning material. To minimize potential confounding variables, factors such as the teaching content, instructional time, and teacher were kept constant across both groups.

Instrument

The data collection instruments consisted of a multiple-choice test and a learning motivation questionnaire. The test consisted of 25 items, aligned with Bloom's Taxonomy, and designed to assess students' cognitive understanding (Anderson & Krathwohl, 2001). The motivation questionnaire was adapted from the Motivated Strategies for Learning Questionnaire (MSLQ), which has been widely used to measure students' motivational and learning strategy dimensions with high validity and reliability (Pintrich et al., 1993).

Research Procedure

The research procedure was carried out in several stages. First, a preparatory phase was conducted, which involved validating the learning materials and instruments through expert review. Following this, both groups were administered a pretest to assess their baseline understanding of the subject matter. Next, the treatment phase lasted two weeks, comprising four 80-minute learning sessions. The experimental group engaged in digital-based instruction utilizing multimedia tools, including interactive videos, simulations, and online quizzes. In contrast, the control group followed a traditional format that involved printed materials, teacher lectures, and manual exercises. After the treatment, a posttest was administered to both groups to measure the extent of knowledge gained. Additionally, students completed the Learning Motivation Questionnaire at the end of the sessions to evaluate their engagement and affective response to the learning process.

Data Analysis Techniques

The data analysis in this study involved both descriptive and inferential statistical methods. Descriptive statistics, including the mean and standard deviation, were used to summarize the students' pretest and posttest scores in both the experimental and control groups. To determine the significance of learning improvement within each group, a paired-sample t-test was conducted to compare the pretest and posttest scores. This test assessed whether the observed gains in learning outcomes were statistically significant for each group individually. An independent-sample t-test was then applied to examine the difference in posttest scores between the experimental group (which used digital media) and the control group (which used conventional media). This analysis tested the hypothesis

that digital learning media would yield higher learning outcomes. Furthermore, the magnitude of the difference between the two groups was measured using Cohen's d to calculate the effect size, which indicates practical significance. A Cohen's d value above 0.8 is considered a significant effect, supporting the educational relevance of the intervention (Cohen, 1988). All analyses were conducted using IBM SPSS Statistics version 25, with a significance threshold set at $p < 0.05$.

RESULT AND DISCUSSION

Result

Descriptive Statistics of Pretest and Posttest Scores

To determine the students' initial academic ability, a pretest was administered prior to the treatment. Both the experimental and control groups showed comparable average scores on the pretest. Following the learning intervention, posttest scores were measured to assess changes in learning outcomes.

Table 1. Descriptive Statistics of Pretest and Posttest Scores

Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gain Score
Experiment	30	57.3	8.5	84.7	7.6	27.4
Control	30	56.8	7.9	70.2	6.8	13.4

The descriptive data indicate that both groups demonstrated improvement from the pretest to the posttest. However, the increase in the experimental group (mean gain = 27.4) was significantly higher than that in the control group (mean gain = 13.4). This suggests that students in the digital learning environment experienced greater academic improvement.

Within-Group Improvement in Learning Outcomes

To assess whether the improvement within each group was statistically significant, a paired-sample t-test was conducted comparing pretest and posttest scores for each group.

Table 2. Paired-Sample t-Test (Pretest vs. Posttest Within Groups)

Group	t-value	df	Sig. (2-tailed)	Mean Difference
Experimental	14.62	29	0.000	27.4
Control	9.13	29	0.000	13.4

The results show that the learning improvement within each group was statistically significant ($p < 0.001$). However, the experimental group demonstrated a more substantial and meaningful improvement compared to the control group, as evidenced by the larger mean difference.

Comparison of Posttest Scores Between Groups

To test the central hypothesis of this study—whether digital media leads to higher learning outcomes than conventional media—an independent-sample t-test was performed on the posttest scores between the two groups.

Table 3. Independent-Sample t-Test (Posttest Between Groups)

Variable	t-value	df	Sig. (2-tailed)	Mean Difference	Cohen's d
Posttest	7.64	58	0.000	14.5	1.82

The result of the independent-sample t-test indicates that the difference in posttest scores between the experimental and control groups is statistically significant ($p < 0.001$). The experimental group outperformed the control group by a margin of 14.5 points. This finding supports the effectiveness of digital media in enhancing student academic achievement.

Effect Size Analysis

In addition to significance testing, the effect size was calculated using Cohen's d to evaluate the magnitude of the difference between the two groups. The value of 1.82 indicates a substantial effect size, based on commonly accepted thresholds (Cohen, 1988), suggesting that the type of media had a significant impact on student learning outcomes. The enormous effect size confirms that digital learning media were not only statistically significant in improving outcomes but also educationally meaningful, providing students with a richer, more interactive learning experience that supports deeper understanding and retention of material.

Discussion

The Effectiveness of Digital Learning Media on Student Learning Outcomes

The findings from this study show a significant improvement in student learning outcomes for those taught using digital learning media compared to those using conventional methods. The experimental group achieved a posttest mean score of 84.7, compared to 70.2 in the control group. This aligns with previous meta-analyses, which report that digital tools, particularly those grounded in multimedia principles, enhance students' cognitive engagement and understanding (Schmid et al., 2014). These improvements are often attributed to features such as visual representation, interactivity, and immediate feedback, which are absent in traditional instructional approaches.

According to Mayer's Cognitive Theory of Multimedia Learning, students learn better from words and pictures than from words alone (Mayer, 2020). Digital learning media, when properly designed, can reduce extraneous cognitive load, promote generative processing, and enhance retention. In this study, the use of animation, interactive quizzes, and audiovisual elements appears to have facilitated deeper comprehension of the subject matter, particularly for abstract concepts that are harder to grasp through static print materials alone.

Comparative Learning Gains Between Groups

When comparing the pretest and posttest scores, both the experimental and control groups demonstrated improvement. However, the gain in the experimental group was markedly higher, with an average increase of 27.4 points compared to 13.4 in the control group. This suggests that digital media did not merely support learning—it accelerated it. This supports findings from Bernard et al. (2009), who noted that blended and online learning modalities tend to produce greater learning gains than face-to-face formats alone.

While conventional methods may offer structure and familiarity, they often lack the dynamic features needed to engage diverse learning styles. In contrast, digital platforms enable differentiated instruction through multimedia content, which can be especially beneficial for students with visual or auditory learning preferences (Clark & Mayer, 2016). The results from this study reinforce that digital learning, when implemented with pedagogical care, can act as a powerful driver of learning outcomes.

Relevance to 21st Century Learning Demands

One of the central implications of this research is its affirmation of the relevance of digital media to 21st-century education. As students are increasingly immersed in digital environments, their learning expectations and cognitive patterns shift toward multimedia-based engagement. The integration of digital tools into pedagogy mirrors the digital literacy demands of the current era, preparing students not only academically but also professionally for a tech-saturated future (Voogt et al., 2013).

Furthermore, the current global emphasis on student-centered and active learning approaches is more easily actualized through digital media. Features such as real-time feedback, gamification, and adaptive learning paths enable learners to take control of their educational experiences. The findings of this study support the argument that incorporating technology into the classroom is no longer a luxury but a pedagogical necessity in promoting meaningful learning.

Pedagogical Implications for Classroom Practice

The significant difference in posttest scores between the experimental and control groups suggests the need for re-evaluating traditional pedagogical methods. Teachers should consider integrating digital media not as a supplementary tool but as an essential part of their instructional strategy. This means rethinking lesson planning, assessment methods, and instructional materials to align with multimedia principles and student needs (Hattie, 2009).

However, successful digital integration requires more than just the availability of technology—it demands teacher training, curriculum adaptation, and readiness of the infrastructure. As emphasized by Lawless and Pellegrino (2007), the effectiveness of educational technology heavily depends on how it is used, rather than merely on the presence of devices. Therefore, capacity-building initiatives should be prioritized to ensure that teachers can design and deliver lessons that leverage the full potential of digital media.

CONCLUSION

The findings of this study suggest that digital learning media have a significant impact on student learning outcomes, surpassing those of conventional instructional approaches. Students in the experimental group demonstrated a greater increase in posttest scores, highlighting the effectiveness of digital media in supporting understanding, engagement, and retention. These results align with Mayer's (2020) cognitive theory of multimedia learning, which posits that students learn more effectively when verbal and visual materials are combined. The implication is clear: educational institutions should prioritize integrating technology into the teaching and learning process to meet the cognitive and motivational needs of 21st-century learners.

Moreover, the study highlights the need for educators to be trained not only in the use of digital tools but also in designing interactive and pedagogically sound digital lessons. Policymakers and curriculum developers should consider incorporating digital literacy and instructional media strategies into teacher education programs. Although the study provides strong evidence for the benefits of digital media, future research should explore its long-term impact across various subjects and learning environments, and consider qualitative methods to examine students' experiences in greater depth. Expanding this research across diverse demographics will also help assess its broader applicability and equity.

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