

"The Effectiveness of the Assure Learning Model Assisted by Audio-Visual Media on Digital Literacy and Conceptual Understanding of Mathematics in Students at SMP Negeri 4 Bolo"

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Abstract

Introduction: The rapid evolution of digital technologies in the Industrial Revolution 4.0 and Society 5.0 eras necessitates that students develop strong digital literacy skills alongside a deep comprehension of mathematical principles. This research examines the efficacy of the ASSURE instructional model, enhanced by audiovisual resources, in boosting digital literacy and conceptual grasp of fractions for students at SMPN 4 Bolo.

Material and Methods: This research adopted a quasi-experimental approach utilizing the Nonequivalent Control Group Design, which included 40 seventh-grade students (20 in the experimental group and 20 in the control group). The experimental group participated in instruction through the ASSURE model enhanced by audiovisual materials, whereas the control group followed standard traditional methods. Data collection tools comprised a digital literacy survey (reliability $\alpha=0.82$) and a test evaluating mathematical concept comprehension ($\alpha=0.85$). The analysis of data incorporated descriptive statistics, an independent samples t-test, and N-gain computations via SPSS version 26.0.

Research Results: The experimental group exhibited a substantial improvement in digital literacy, rising by 26.2 points (mean pretest=52.3; mean posttest=78.5), in contrast to the control group's modest gain of 9.4 points (mean pretest=51.8; mean posttest=61.2). Regarding mathematical conceptual understanding, the experimental group advanced by 33.6 points (mean pretest=48.7; mean posttest=82.3), whereas the control group progressed by just 14.3 points (mean pretest=49.2; mean posttest=63.5). Results from the independent samples t-test confirmed notable differences ($p<0.05$), supported by high effect sizes (Cohen's $d=2.63$ for digital literacy; $d=2.89$ for conceptual understanding). Furthermore, the N-gain assessment indicated that the experimental group attained a moderate level ($g=0.55$ and $g=0.65$).

Conclusion: The ASSURE learning model assisted by audio-visual media proved effective in significantly improving students' digital literacy and mathematical conceptual understanding. This study contributes theoretically to the integration of digital literacy with mathematical conceptual understanding, and practically to teachers in designing innovative technology-based learning that meets 21st-century educational demands.

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1. INTRODUCTION

Mathematics education in the 21st century demands the integration of two key competencies: digital literacy and conceptual understanding of mathematics. Literacy encompasses an individual's ability to critically access, evaluate, and produce digital content (Wang et al., 2022). Meanwhile, conceptual understanding of mathematics refers to the ability to grasp the essential meaning, relationships between ideas, and the application of concepts in various contexts (Pramudiani & Dolk, 2025). These two competencies complement each other; improving digital literacy can enrich the

representation and delivery of mathematical concepts through technology-based media, making the learning process more effective and meaningful (G. I. Sari et al., 2024).

Fractions are a fundamental topic in junior high school (SMP), serving as the foundation for mastering advanced concepts such as comparison, percentages, algebra, and statistics. However, various studies have shown that students' understanding of fractions remains low. This phenomenon is evident in the emergence of misconceptions in arithmetic operations, difficulties in comparing fractions, and students' tendency to memorize procedures without understanding their conceptual meaning (Jarrah et al., 2022; E. F. Sari et al., 2024). If this condition is not addressed immediately, it could potentially hinder mastery of advanced mathematics.

Initial observations at SMPN 4 Bolo showed that most students struggled to solve fraction problems, especially when asked to explain the conceptual reasoning behind their answers. Furthermore, students were not yet accustomed to optimally utilizing digital learning resources. In the context of 21st-century education, the ability to access, manage, and utilize digital information is a crucial competency (Hamid et al., 2024). Low digital literacy, coupled with a weak conceptual understanding of mathematics, underscores the importance of implementing innovative learning models that align with technological developments.

A survey of 385 students from 12 junior high schools in Madiun City showed that the ability to use media, operate digital platforms, and manage learning media was still around 50%, indicating low student independence in managing digital media (Harmawati et al., 2024). The results of Rahma and Nurlaelah's (2024) meta-analysis showed that digital technology has a moderate effect on improving the mathematics achievement of junior high school students in Indonesia, especially in visual and conceptual materials. These findings indicate that limited digital literacy can be a factor that hinders students' mathematical understanding.

Digital integration in mathematics learning has been shown to increase student engagement and problem-solving skills. The use of open digital tools in STEM learning can strengthen problem-solving skills and increase student learning autonomy (Blanc et al., 2025). Research by Salahuddin (2023) also shows that the use of instructional video media can significantly improve media literacy and student interaction with mathematical content. Meanwhile, Joshi (2025) proves that the use of digital resources both inside and outside of school has a positive effect on mathematics achievement. St. Omer (2025) adds that technology-based interactive and collaborative learning supports knowledge construction and active student participation, which positively impacts mathematics learning outcomes.

Audio-visual media such as interactive simulations, animations, and learning videos have been proven to help students understand the concept of fractions. These media not only improve learning outcomes but also help students visualize concepts that are difficult to explain through text or verbal explanations alone (Al Farra et al., 2024; Azhari & Suwendra, 2024). Recent research shows that the use of audio-visual media can increase students' cognitive engagement because it provides concrete representations of abstract concepts and supports various learning styles, both visual and auditory (Eliana et al., 2024; Manulang et al., 2023). Furthermore, interactive media based on video animation can strengthen conceptual understanding and develop critical thinking skills and mathematical problem-solving in a realistic context.

To optimize the use of learning media, a systematic learning design is required. The Assure Model (Analyze Learners, State Objectives, Select Methods/Media/Materials, Utilize Media, Require Learner Participation, Evaluate and Revise) provides a conceptual framework for teachers in designing, implementing, and evaluating technology-based learning (Lei, 2024; Tangjitnusorn, 2023). This model emphasizes the importance of analyzing learner characteristics, formulating clear objectives, selecting appropriate media, and active student participation in the learning process (Salahuddin & Yamin, 2021). This study shows that the application of the Assure model supported by

audio-visual media can improve learning interactivity, concept retention, and 21st-century skills such as creativity, critical thinking, and collaboration (Eliana et al., 2024).

Although extensive research has been conducted on digital literacy and mathematical conceptual understanding, most of these aspects are discussed separately and have not integrated them into a comprehensive learning design. Some studies focus solely on improving skills through information technology without linking them to mathematical conceptual understanding (Ramdhani et al., 2022; Wang et al., 2022). Conversely, studies on conceptual understanding are often limited to cognitive aspects without considering digital literacy as an essential 21st-century competency. To date, research examining the effectiveness of the Assure model, supported by audio-visual media, in improving digital literacy and understanding of fraction concepts at the junior high school level is still limited, particularly in local contexts such as SMPN 4 Bolo, which has different characteristics compared to urban schools.

This study aims to address this gap by providing empirical evidence on the effectiveness of the audio-visual-assisted Assure model in improving students' digital literacy and conceptual understanding of mathematics. Theoretically, this study contributes to enriching the integrative study of digital literacy and mathematics learning. Practically, this study provides recommendations for educators in designing learning strategies that align with technological advances. The results of this study are expected to serve as a reference for other schools, especially in areas with limited technological facilities, to optimize interactive, contextual, and relevant mathematics learning to meet the demands of the digital era.

2. MATERIALS AND METHODS

A. Theoretical Study

1. Digital Literacy in Mathematics Learning

Digital literacy is the ability to access, understand, evaluate, and utilize digital-based information responsibly, ethically, and productively. In the context of mathematics learning, digital literacy encompasses two main dimensions: technical skills in operating digital devices and critical thinking skills in selecting and managing information from various online sources (Wang et al., 2022). Mastery of digital literacy is believed to increase students' learning independence, motivation, and active participation in mathematical problem-solving (Ramdhani et al., 2022; Salahuddin et al., 2024). Through the use of video-based learning platforms, interactive simulations, and other digital resources, students can deepen their conceptual understanding independently and repeat learning according to individual needs.

As an essential competency in the 21st century, digital literacy needs to be developed from secondary school onward, as it plays a crucial role in shaping a generation that is adaptable to global technological developments. Lack of digital literacy skills can hinder students from adapting to the dynamics of modern learning, which is increasingly integrated with technology. This poses a particular challenge in mathematics, which requires simultaneous visual, numerical, and logical representation skills for a deep understanding of concepts.

2. Conceptual understanding in Mathematics

Mathematical conceptual understanding is defined as a student's ability to grasp the essence, connect ideas, and apply them to previously unfamiliar contexts. This ability facilitates the mechanical mastery of procedural techniques as well as a logical understanding of each stage of problem-solving. Especially in fraction teaching, which involves symbolic, visual, and verbal representations, conceptual understanding is a crucial element in avoiding conceptual errors and misconceptions (Pramudiani & Dolk, 2025). Studies indicate that students' difficulty integrating visual, symbolic, and verbal representations is a major challenge in grasping fractions, which often leads to rote memorization without fundamental understanding (Agustin & Junaedi, 2024).

Learning approaches utilizing digital media and manipulative tools were specifically developed to address these challenges. The application of manipulative media supports students in optimally understanding fraction operations through direct involvement in the exploration process (Al Ayyubi et al., 2025). Sari (2024) also stated that integrating animation into mathematics teaching effectively reduces misconceptions by illustrating fractions. Ulfah and Malik (2025) observed that interactive digital quiz-based instruments, such as Kahoot, can increase student participation and facilitate an efficient understanding of the concept of fractions with different denominators. Husain (2025) demonstrated that fraction smart cards designed using the ADDIE model are not only practical but also effective in helping students internalize fractions.

3. Utilization of Audio-Visual Media in Mathematics Learning

Audiovisual media, such as video, animation, and interactive simulations, play a role in transforming abstract mathematical concepts into more tangible and easily digestible forms for students. Strategic use of these media, by presenting information simultaneously through text, visual elements, and audio elements, can strengthen cognitive abilities, minimize mental overload, and improve the ability to store information in long-term memory (Kurniawati et al., 2018). This fact confirms that audiovisual media is not merely a means of entertainment or supplementation, but an essential component in the normal learning process.

Agustin and Junaedi (2024) observed that PowToon media successfully improved students' understanding of fractions while also stimulating learning motivation, with N-gain values in the moderate to high range. Similar results were reported by Yusriza and Kowiyah (2023), where students who learned fractions through videos achieved superior learning achievement than the group using traditional methods. Setiawati (2024), through a meta-analysis review, concluded that interactive audiovisual media can increase student engagement, conceptual understanding, and intrinsic learning motivation. Furthermore, Dewantari (2024) found that animated videos based on Realistic Mathematics Education (RME) supported elementary school students in solving issues related to fractions. Azhari and Suwendra (2024) showed that audiovisual media significantly improved students' ability to calculate fractions compared to conventional strategies.

4. Assure Learning Model in Audio-Visual Media Integration

Assure Instructional Model (*Analyze Learners, State Objectives, Select Methods/Media/Materials, Utilize Media, Require Learner Participation, Evaluate and Revise*) is the foundation of learning design that emphasizes continuous assessment, proactive student engagement, and media optimization to ensure that learning technology and tools are tailored to students' needs and educational goals (Tangjitnusorn, 2023). The implementation of the Assure model is considered highly appropriate in the context of the digital era because it allows for the integration of educational technology, particularly audio-visual media that present relevant and engaging content (Japar et al., 2024).

Contemporary research confirms that the Assure application, supported by audio-visual media, has a significant positive impact. Nasfovi and Parmiti (2023) revealed that developing interactive videos based on Problem-Based Learning (PBL) using the Assure framework was effective in increasing student participation and reducing mathematical misconceptions. The Assure model, enriched with audio-visual media, is seen as an appropriate, innovative strategy for integrating digital literacy while strengthening students' conceptual understanding. The combination of the Assure model with audio-visual media has been proven to support the improvement of digital literacy, where students are guided to search for, utilize, and filter digital information analytically and effectively through technological simulations, instructional videos, and animations (Lei, 2024).

5. The relationship between digital literacy, conceptual understanding, audio-visual media and the Assure Model

The integration of digital literacy, conceptual understanding, audio-visual media, and the Assure model forms a holistic and cutting-edge research structure. Conceptual understanding enables students to delve deeper into the meaning of mathematics, while digital literacy strengthens their ability to access and manage information sources. Conceptual understanding ensures that students are not trapped in mere memorization of routines but are instead able to connect ideas to become more resilient in facing complex problems (Agustin & Junaedi, 2024). The Assure model structures all elements in a learning design, with audio-visual media serving as a link to translate abstract concepts into concrete elements.

Dewi and Agustika (2022) demonstrated that developing videos based on the Assure model is a credible and successful approach to improving student learning outcomes. Audiovisual media provides visualizations, animations, and simulations that facilitate material processing, thereby concretizing abstract ideas such as fractions. Interactive animated videos can enrich the affective, emotional, and cognitive dimensions of student engagement in mathematics instruction (Setiawati, 2024; Windarti et al., 2022). Divayani and Agustina (2024) demonstrated that contextual problem-based video animations are effective in deepening students' ability to understand fractions because the content is more aligned with everyday experiences.

The integration of these strategies emphasizes the urgent need to integrate digital literacy, conceptual understanding, audiovisual media, and the Assure model into instructional design. This research aims to bridge the gap in academic and practical areas, as most previous studies have focused on only one or two components in isolation. Research that simultaneously integrates these four aspects in teaching fractions at the junior high school level, particularly at SMPN 4 Bolo, remains scarce.

B. Research Methods

a. Research Design

This study employed a Quasi-Experimental approach based on a Nonequivalent Control Group Design. This design was chosen based on practical factors within the educational environment of SMPN 4 Bolo, where total randomization is difficult due to the potential for disrupting the established classroom atmosphere. As stated by Campbell and Stanley (1963), this design offers a good level of internal validity thanks to the use of pre-test and post-test controls and measurements, which are able to overcome validity risks such as the influence of history, maturation, and testing effects. Furthermore, Creswell and Creswell (2018) stated that the quasi-experimental method is an appropriate option for evaluating the success of educational interventions in natural environmental conditions.

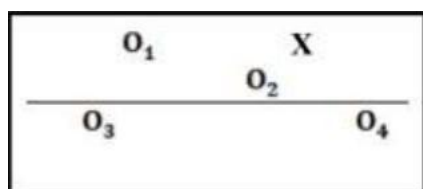


Figure 1. Research Design Plan

Information :

X = Treatment

O₁ = Pretest of experimental class

O₂ = Posttest of experimental class

O₃ = Pretest control class

O₄ = Posttest control class

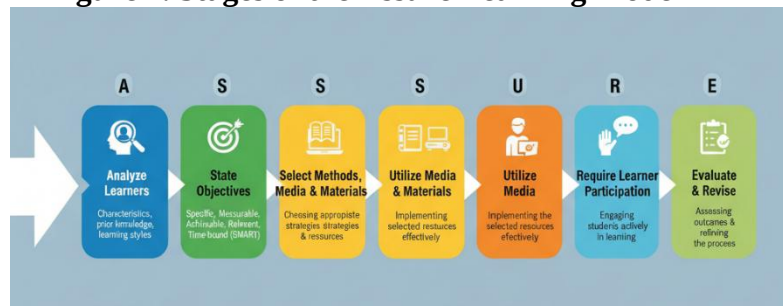
This study included 40 seventh-grade students at SMPN 4 Bolo, who were divided into two groups: an experimental class (n=20) and a control class (n=20). A purposive sampling technique was applied to select the sample, considering criteria such as uniformity in learning abilities, access to technological facilities, and teachers' readiness to collaborate. As described by Etikan (2016), purposive sampling is an appropriate choice when researchers need participants with specific attributes that support the research objectives.

b. Data Collection Procedures

The data collection process was conducted in four stages over eight days. The initial stage, preparation (days 1-2), included the development of teaching materials, expert assessment of the validity of the measuring instrument, and preliminary testing of the instrument. The second stage (day 3) focused on measuring the initial conditions of digital literacy and understanding of mathematical concepts in both groups through a pre-implementation test. The third stage, implementation of learning activities (days 4-7), was carried out with different strategies for each group. The experimental group implemented the ASSURE model enriched with audiovisual media, which consists of six main steps:

- Analyze Learners – assessment of student characteristics
- State Objectives – formulation of learning targets
- Select Methods/Media/Materials – determining strategies, tools, and resources
- Utilize Media – systematic use of media
- Require Learner Participation – encourage student participation through discussion and hands-on practice
- Evaluate and Revise – interactive assessment and modification.

Figure 2. Stages of the Assure Learning Model



c. Data Analysis Techniques

The data processing was carried out using descriptive and inferential statistical approaches through SPSS software version 26. Descriptive analysis included the calculation of the average (mean), standard deviation (standard deviation), smallest (minimum), and largest (maximum) values. The level of success of the increase was measured using the N-gain formula according to Hake (1999), namely

$$g = \frac{\text{Shoes posttest} - \text{Shoes pretest}}{\text{Shoes maximum} - \text{Shoes Prettest}}$$

with classification: high ($g \geq 0.7$), medium ($0.3 \leq g < 0.7$), and low ($g < 0.3$).

The analysis requirements examination involves a normality test applied with a significance criterion greater than 0.5 to declare the data normally distributed, while the homogeneity test is performed using Levene's Test (data is considered homogeneous if the significance > 0.05). If these requirements are met, hypothesis testing is continued with an

Independent Sample t-test, where the null hypothesis (H_0) is rejected if the significance is < 0.05 .

The impact size of the intervention is calculated using Cohen's d with the formula:

$$d = \frac{M1 - M2}{SD \text{ pooled}}$$

The interpretation follows Cohen (1988) which is grouped into three levels of effect, namely small ($d = 0.2$), medium ($d = 0.5$), and large ($d \geq 0.8$). The determination of overall effectiveness is based on the fulfillment of three conditions, namely 1.) The results of the analysis show a statistically significant difference ($p < 0.05$), 2.) the effect size at a medium to large level ($d \geq 0.5$), and 3.) the N-gain value in the experimental group is superior with a category of at least medium ($g \geq 0.3$).

This study involved a total of 40 seventh-grade students at SMPN 4 Bolo, who were intentionally divided into two balanced groups to compare the effectiveness of the intervention. The experimental group, consisting of 20 students, implemented an Assure model-based learning approach enriched with interactive audio-visual media such as videos and animations to improve digital literacy and understanding of mathematical concepts related to fractions. Meanwhile, the control group, also consisting of 20 students, followed a conventional learning method that relies more on teacher lectures and manual exercises, without advanced technology elements. This division was carried out using a purposive sampling technique to ensure uniformity in initial abilities, access to facilities, and support from educators so that the research results can more accurately reflect the impact of the intervention in a natural educational environment.

3. RESULTS

a. Description of Digital Literacy Data

Table 1. Descriptive Digital Literacy

Group	n	Pretest (Mean $\pm$ SD)	Min - Max	Posttest (Mean $\pm$ SD)
Experiment	20	52,3 $\pm$ 6,2	42 – 65	78,5 $\pm$ 5,8
Control	20	51,8 $\pm$ 6,5	40 – 63	61,2 $\pm$ 7,1

The results of the pretest showed that both groups had relatively balanced initial abilities, with an average score of 52.3 in the experimental group and 51.8 in the control group. This finding indicates that the digital literacy level of students at SMPN 4 Bolo is still in the low category, especially in terms of the use of digital learning media, the assessment of digital information sources, and critical information management. After being given treatment, the experimental group showed a statistically significant increase, with an average posttest score of 78.5, while the control group only obtained an average of 61.2. The increase in the experimental group's score of 26.2 points far exceeded the 9.4 point increase achieved by the control group. This confirms that the implementation of the Assure model supported by audio-visual media has proven effective in improving digital literacy. Students when compared with conventional learning.

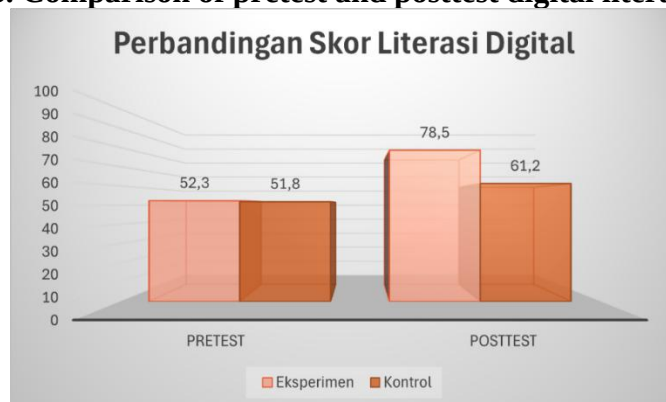
Figure 3. Comparison of pretest and posttest digital literacy scores

Figure 3 shows that the pretest scores of both groups were nearly equal, with the experimental group achieving 52.3 and the control group achieving 51.8. However, after the treatment was administered, the posttest results showed a significant difference, with the experimental group showing a significantly higher increase of 26.2 points compared to the control group, which only increased by 9.4 points. The results of this study indicate that the implementation of the Assure learning model combined with audio-visual media has proven effective in improving digital literacy.

b. Description of Conceptual Understanding of Mathematics Data

Table 2. Descriptive Statistics of Conceptual Understanding of Mathematics

Group	n	Posttest (Mean $\pm$ SD)	Min - Max	Pretest (Mean $\pm$ SD)
Experiment	20	48,7 $\pm$ 7,3	35 – 62	82,3 $\pm$ 6,4
Control	20	49,2 $\pm$ 7,8	38 – 65	63,5 $\pm$ 8,2

The pretest for understanding mathematical concepts showed balanced initial scores: 48.7 (experimental) and 49.2 (control), indicating students' difficulties in explaining the rationale for procedures and connecting fractional representations. Posttest: the experimental group achieved 82.3 (an increase of 33.6 points), in contrast to the control group's 63.5 (an increase of 14.3 points). This significant improvement demonstrates the effectiveness of the audiovisual-based ASSURE model in strengthening students' conceptual understanding.

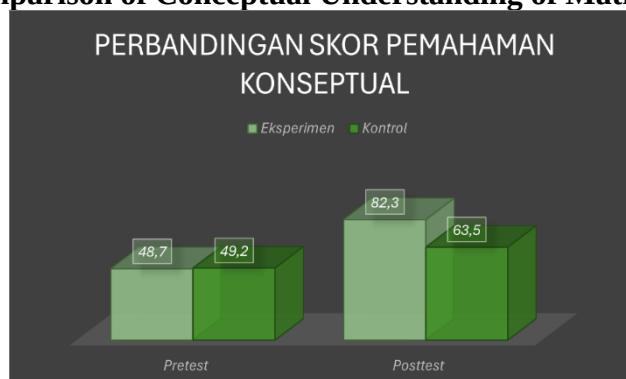
Figure 4. Comparison of Conceptual Understanding of Mathematics scores

Figure 4 displays a pattern similar to the findings in digital literacy. Both groups demonstrated nearly equal initial abilities, with scores of 48.7 in the experimental group and 49.2 in the control group. However, the experimental group experienced a significant jump of 33.6 points, far exceeding the 14.3-point increase experienced by the control group. These results underscore that the application of audio-visual media within the Assure model framework successfully deepened students' understanding of fraction concepts.

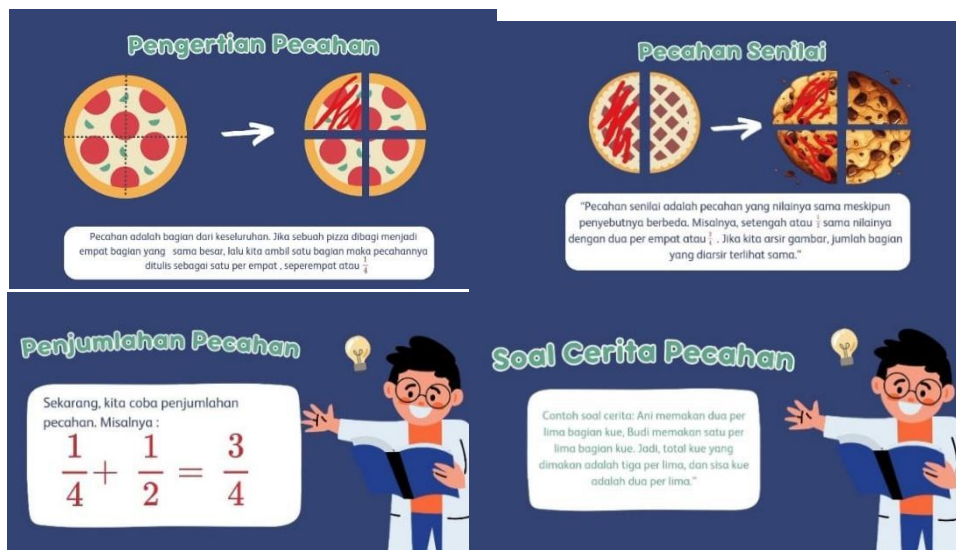


Figure 5. Several video clips of learning the concept of fractions using the Assure Learning Model assisted by Audio-Visual Media(Source: Researcher Documentation)

Figure 5 displays a video clip of a fraction concept lesson developed by researchers using the ASSURE model based on audiovisual media. This video is designed to help students understand the part-whole relationship of fractions through engaging visuals and systematic explanations, including concept introduction, pictorial representation, and everyday applications. Its creation implemented the Select Methods, Media, and Materials and Utilize Media stages in ASSURE, which emphasize media selection based on student characteristics. The simultaneous use of visuals and audio is expected to improve conceptual understanding and make it easier for students to recognize and differentiate fractions.

c. Prerequisite Analysis Test

Before conducting the hypothesis test, normality and homogeneity tests were carried out to verify that the data met the requirements of parametric assumptions.

Table 3. Results of Normality Test (Shapiro-Wilk Test)

Variables	Group	Statistics	df	Say.	Conclusion
Digital Literacy (Pretest)	Experiment	0,956	20	0,462	Normal
	Control	0,948	20	0,328	Normal
Digital Literacy (Posttest)	Experiment	0,961	20	0,562	Normal
	Control	0,953	20	0,408	Normal
Conceptual Understanding of Mathematics (Pretest)	Experiment	0,950	20	0,365	Normal
	Control	0,945	20	0,289	Normal
Conceptual Understanding of Mathematics (Posttest)	Experiment	0,958	20	0,509	Normal
	Control	0,951	20	0,381	Normal

Table 3 shows that all significance values exceed 0.05, indicating that the pretest and posttest distributions for both variables in both groups are normal. Therefore, the normality requirement for the parametric test has been met.

Table 4. Results of the Homogeneity Test (Lavene's Test)

Variables	Lavene Statics	Df1	Df2	Say.	Conclusion
Experiment (Posttest)	0,854	1	38	0,361	Homogeneous
Control (Posttest)	1,265	1	38	0,268	Homogeneous

The homogeneity test findings revealed that the variance between the two groups was homogeneous ($p > 0.05$) for both variables. This condition indicates that the homogeneity of variance requirement for the independent sample t-test has been met. Given that both assumptions of normality and homogeneity have been verified, the analysis process can proceed further using a parametric statistical test approach.

d. Hypothesis Testing and Effect Size

Table 5. Results of Independent Sample T-test and Effect Size

Variables	t-count	df	Sig. (2-tailed)	Mean Difference	Cohen's D	Category Effect Size	Conclusion
Digital Literacy	8,32	38	0,000	17,30	2,63	Big	Significant
Conceptual Understanding of Mathematics	9,15	38	0,000	18,80	2,89	Big	Significant

An independent t-test revealed highly significant differences between the experimental and control groups on both variables. For digital literacy, the t-test was 8.32 with $p = 0.000$ (<0.05), and Cohen's $d = 2.63$ (a large effect). Similarly, conceptual understanding of mathematics showed a t-test of 9.15, $p = 0.000$ (<0.05), and Cohen's $d = 2.89$ (a large effect). According to Cohen (1988), a d value > 0.8 reflects a statistically and practically meaningful difference. These findings demonstrate that the audiovisual media-based ASSURE model not only produces significant improvements but also has a substantial impact on students' digital literacy and understanding of mathematical concepts.

e. N-gain Analysis

In order to determine the level of effectiveness of improvement in each group, N-gain analysis was applied with the formula $N\text{-gain} = (\text{Posttest Score} - \text{Pretest Score}) / (\text{Maximum Score} - \text{Pretest Score})$. The N-gain classification refers to Hake's (1999) criteria, namely high ($g \geq 0.7$), medium ($0.3 \leq g < 0.7$), low ($g < 0.3$).

Table 6. Distribution of N-gain in Both Groups

Variables	Group	High	Currently	Low	N-gain rate	Category
Digital Literacy	Experiment	35% (7)	60% (12)	5% (1)	0,55	Currently
	Control	0% (0)	25% (5)	75% (15)	0,19	Low
Conceptual Understanding of Mathematics	Experiment	45% (9)	50% (10)	5% (1)	0,65	Currently
	Control	5% (1)	30% (6)	65% (13)	0,28	Low

The results of the N-gain analysis show that the experimental group achieved an average N-gain of 0.55 in digital literacy, which is in the medium category, and 0.65 in conceptual understanding of mathematics, which is in the medium to high category. In contrast, the control group only achieved an N-gain of 0.19 for digital literacy and 0.28 for conceptual understanding of mathematics, both of which are in the low category. Table 6 shows a striking difference in the N-gain categories between the two groups. In the experimental group, the majority of students experienced an increase from the medium to high category, with 35% of students reaching the high category for digital literacy and 45% for conceptual understanding. In contrast, in the control group, the majority of students, namely 75% in digital literacy and 65% in conceptual

understanding of mathematics, were only in the low category. This variation in distribution further confirms the findings obtained.

4. CONCLUSION

This study demonstrates that the ASSURE approach, supported by audiovisual media, is effective in simultaneously improving students' digital literacy and mathematical conceptual understanding. Success is evident in students' progress in critically utilizing, analyzing, and managing digital information, as well as a deeper understanding of fraction concepts, including their representation, operations, and applications in everyday life. Key findings include: (1) The experimental group gained 26.2 points in digital literacy and 33.6 points in conceptual understanding, significantly exceeding the control group (9.4 and 14.3 points); (2) Statistically significant differences ($p < 0.05$) with strong effects (Cohen's $d = 2.63$ for digital literacy; $d = 2.89$ for conceptual understanding); and (3) Moderate N-gain in the experimental group ($g = 0.55$ and 0.65), in contrast to low in the control group ($g = 0.19$ and 0.28).

The mutually supportive relationship between digital literacy and mathematical conceptual understanding provides new theoretical insights. Improved digital literacy broadens access to diverse learning resources, which strengthens conceptual understanding. Conversely, a solid conceptual foundation enables more targeted use of technology in mathematics learning. This interaction emphasizes the need for integrated development of both within a holistic learning design. Practically, this study demonstrates that technology-based interactive mathematics learning can be implemented in schools with minimal facilities. The success at SMPN 4 Bolo demonstrates that the key factors are structured planning, teacher creativity in maximizing resources, and active student engagement, not the level of technology itself. The implications of this study are: (1) Theoretical: Enriching the study of the integration of digital literacy and conceptual understanding in structured learning models; (2) Practical: Providing direction for teachers to design optimal technology-based instruction; and (3) Policy: Encouraging schools to incorporate digital literacy and conceptual understanding into the mathematics curriculum.

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