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Annisa Stabita, Sari Herlina 

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Effects of Video-Assisted 5E Learning Cycle Instruction on Mathematical Literacy

Annisa Stabita^{1*}, Sari Herlina¹ 

¹Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Islam Riau

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ABSTRACT

This study aimed to examine the effect of a video-assisted 5E Learning Cycle model on Grade 11 students' mathematical literacy at SMA Negeri 3 Siak Hulu. A quasi-experimental method with a nonequivalent control group design was employed. The study is timely in a global context, as mathematical literacy is widely recognized as a key 21st-century competency. The population comprised all Grade 11 students at SMA Negeri 3 Siak Hulu in the 2024/2025 academic year. Using purposive sampling, two intact classes were selected: Class XI.3 (n = 35) as the experimental group and Class XI.2 (n = 35) as the control group. Data were collected using pretest and posttest instruments and analyzed through descriptive and inferential statistics. The findings indicated a difference in the mean mathematical literacy scores between the experimental and control groups. Therefore, it can be concluded that video-assisted 5E Learning Cycle instruction had a significant effect on students' mathematical literacy. This study contributes to the literature by providing evidence on the effectiveness of an innovative, video-supported instructional model and offers practical implications for implementing more effective and sustainable mathematics learning.



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Corresponding Author:

Lorenza Puspita Sari,
Mathematics Education Study Program,
Faculty of Teacher Training and Education,
Universitas Islam Riau,
Kaharuddin Nasution Street No. 113, Perhentian Marpoyan, Marpoyan Damai Subdistrict, Pekanbaru City,
Riau Province, Indonesia
Email: stabitaannisa@gmail.com

Introduction

Education is essentially a process that prepares individuals to survive and adapt to their environment through the development of life skills (Dewi & Septa, 2019). In education, learners are equipped with conceptual and procedural abilities and are guided to apply these concepts in real life (Rahayu et al., 2021). Mathematics, as one of the core fields of education, plays an important role in equipping learners to solve various real-life problems (Mauliya, 2024). Mathematics is not only a tool for calculation, but also a means of developing logical, critical, and systematic thinking (Sukendra & Sumandya, 2020). Fundamentally, mathematics is

logical and structured, requiring students to engage in systematic reasoning, problem-solving, and abstract thinking (Sehrawat, 2024).

However, in practice, mathematics is still considered difficult by many students. This perception can lead to fear, low learning motivation, and a tendency to memorize concepts without truly understanding their meaning (Erdiansyah, 2022). This condition contributes to the low level of mathematical literacy among Indonesian students. Mathematical literacy, according to Anwar (2018), is an individual's ability to use mathematical knowledge to understand, formulate, and solve everyday problems effectively. The OECD/PISA framework also emphasizes that mathematical literacy involves not only conceptual understanding but also the ability to analyze, reason, and communicate mathematical ideas in contextualized situations (Nurjamil et al., 2021).



Figure 1. Average Mathematics Literacy Score in Indonesia

Based on the average mathematics literacy score in Indonesia in 2022, which was 366, various studies have reported that Indonesian students' low mathematical literacy is influenced by limited exposure to contextual problems, insufficient practice in reasoning and argumentation, and limited teacher creativity in facilitating problem-solving-oriented learning (Kusuma, 2017). Therefore, alternative learning models are needed to provide space for students to think critically, explore concepts, and solve problems independently. One relevant model is the 5E Learning Cycle, which consists of five stages: engagement, exploration, explanation, elaboration, and evaluation (Annisa, 2022). This student-centered model enables learners to observe phenomena, construct concepts, and test explanations independently (Unaenah & Rahmah, 2019). The 5E Learning Cycle is closely aligned with the constructivist learning approach and can be used effectively, particularly in science education contexts (Varoglu et al., 2023). As a constructivist-oriented model, the 5E Learning Cycle emphasizes students' prior knowledge and learning experiences and aims to improve conceptual understanding (Liana, 2020).

Previous research has shown that implementing the 5E Learning Cycle can increase teacher and student activity as well as improve mathematics learning outcomes (Khoitin et al., 2018). However, a research gap remains. Although the 5E Learning Cycle has been widely studied, few studies have specifically integrated this model with instructional video media to improve mathematical literacy at the senior high school level, particularly in the Indonesian context. In fact, learning videos can present material more concretely, provide authentic real-life contexts, and support students in understanding mathematical concepts. Based on the above rationale, this study addresses the need for an innovative learning approach that can improve students' mathematical literacy. This study aims to analyze the effect of implementing the 5E Learning Cycle assisted by instructional videos on the mathematical literacy on the topic of scatter diagrams.

Method

Types of Research

Research methods refer to systematic, planned, scientific, and rational procedures used to collect and analyze data in order to achieve specific objectives (Harahap, 2020; Waruwu, 2023). They can also be defined as scientific ways of obtaining data for particular purposes and uses (Priadana & Sunarsi, 2021). In addition, research methods include reliable and trustworthy procedures for collecting and analyzing data to generate knowledge (Sari et al., 2023). This study employed a quasi-experimental method using a pretest–posttest control group design. A quasi-experiment is an experimental study that involves treatment and measurement of outcomes, but does not use random assignment to form comparison groups (Abraham & Supriyati, 2022). This design is appropriate for testing the effectiveness of a treatment or learning model in existing school classes where randomization is difficult because classes have been predetermined by the school. Therefore, this quasi-experimental approach provides a reasonable basis for examining the effect of the video-assisted 5E Learning Cycle model on students' mathematical literacy. In this design, two intact classes were selected and assigned as the experimental group and the control group. Both groups were given a pretest and a posttest (Banuwa & Susanti, 2021). The experimental group received instruction using the video-assisted 5E Learning Cycle model, whereas the control group received conventional instruction. Pretest scores were used to examine baseline equivalence between groups, and posttest scores were analyzed to determine the effect of the treatment.

Table 1. Design Study

<i>Pretest</i>	<i>Treatment</i>	<i>Posttest</i>
O_1	X	O_2
O_3	-	O_4

Samples

A population refers to a defined group of individuals or objects that share particular characteristics and from which conclusions can be drawn (Abdullah et al., 2022). A sample is a subset of the population selected to represent the population when researchers face limitations in time, cost, and resources (Sugiyono, 2020). The population of this study consisted of all Grade XI students at SMA Negeri 3 Siak Hulu, comprising seven classes (XI.1 to XI.7). Purposive sampling was used to select classes relevant to the research objectives (Lenaini, 2021), namely Grade XI students who were learning scatter diagrams. Based on this criterion, Class XI.2 was selected as the control group ($n = 35$) and Class XI.3 as the experimental group ($n = 35$).

Instruments

Research instruments are tools used to collect data (Fauziyah et al., 2023). This study used two main instruments: (1) a mathematical literacy test and (2) an observation sheet for learning implementation. The mathematical literacy test consisted of a pretest and a posttest designed to assess students' mathematical literacy. The literacy indicators assessed included conceptual understanding, problem-solving, the use of mathematics in real-life contexts, and critical thinking. The observation sheet was used to evaluate the extent to which the learning process was implemented as planned, particularly the implementation fidelity of the video-assisted 5E Learning Cycle model during the treatment sessions.

Data Collection

Data collection techniques refer to procedures used to obtain the required information and to ensure that the collected data are valid and authentic (Ardiansyah et al., 2023). This study employed three techniques: testing, classroom observation, and an instrument try-out. The test was administered twice, namely a pretest conducted before the intervention to measure students' initial mathematical literacy and a posttest administered after the intervention to examine students' mathematical literacy following instruction using the video-assisted 5E Learning Cycle model. In addition, classroom observations were carried out during the intervention to assess the implementation fidelity of the video-assisted 5E Learning Cycle model and to document how learning activities were conducted in the classroom. An instrument try-out was also conducted to ensure that the mathematical literacy test produced valid and reliable data; item analysis covered validity, reliability, difficulty level, and discrimination index, and the analysis was performed using Anates version 4.0 (Karindi & Rufi'i, 2024).

Data Analysis

Data analysis is the process of transforming raw data into meaningful information (Ulfah et al., 2022). In this study, data analysis consisted of descriptive analysis, inferential analysis, and learning implementation analysis. Descriptive statistics were used to summarize students' mathematical literacy scores, including the mean, standard deviation, and score distribution for both pretest and posttest results. Inferential statistics were then used to test the research hypothesis regarding differences in mathematical literacy between the experimental group and the control group. A normality test was conducted to examine the distribution of the data, and a homogeneity test was used to assess the equality of variances between groups. An independent samples t-test was applied to compare the mean scores of the two groups; if the data did not meet parametric assumptions, the Mann–Whitney U test was used as an alternative. The decision rule applied was that Sig. > 0.05 indicates normally distributed data, whereas Sig. < 0.05 indicates non-normal data. The research hypothesis stated that there is a significant difference in students' mathematical literacy between the experimental group taught using the video-assisted 5E Learning Cycle model and the control group taught using conventional instruction. Finally, learning implementation analysis was conducted to evaluate whether the video-assisted 5E Learning Cycle model was implemented according to the lesson plan, since implementation fidelity can influence the validity of the research findings and help explain the results (Figure 2).

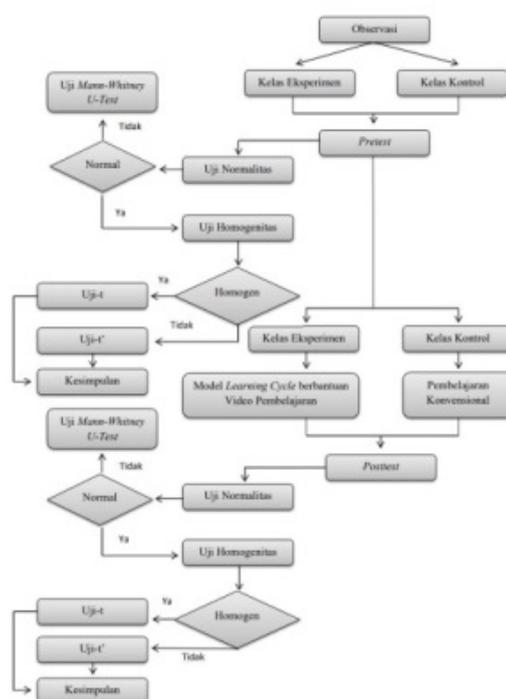


Figure 2. Data Processing Procedure

Research Results

Table 2 presents the descriptive statistics of students' mathematical literacy scores in the experimental and control groups. Both groups had comparable pretest scores. The experimental group obtained a mean pretest score of 26.28 (SD = 7.62), while the control group obtained 26.34 (SD = 5.27). After the intervention, the experimental group showed a substantial improvement, with a mean posttest score of 88.00 (SD = 8.06), whereas the control group reached 73.00 (SD = 12.67). These results indicate that students who learned through the video-assisted 5E Learning Cycle model achieved higher mathematical literacy scores than those who learned through conventional instruction.

Table 2. Descriptive Statistics of Pretest and Posttest Scores in the Experimental and Control Groups

Statistic	Pretest (Experimental)	Pretest (Control)	Posttest (Experimental)	Posttest (Control)
N	35	35	35	35
Minimum	17.00	21.00	75.00	50.00
Maximum	42.50	34.50	100.00	100.00
Sum	920.00	922.00	3080.00	2555.00
Mean	26.28	26.34	88.00	73.00
Standard Deviation	7.62	5.27	8.06	12.67

Assumption Testing

Inferential analysis in this study required testing normality and homogeneity assumptions. When the data do not meet the normality assumption, a non-parametric test must be used. Normality test (pretest). Table 3 shows that the significance values for both groups were below

0.05, indicating that the pretest data were not normally distributed. Therefore, the study used the Mann–Whitney U test to examine whether the two groups differed at baseline.

Table 3. Normality Test Results for Pretest Scores in the Experimental and Control Groups

Tests of Normality

Group	Kolmogorov–Smirnov (Lilliefors) Statistic	df	Sig.	Shapiro–Wilk Statistic	df	Sig.
Experimental	0.152	35	0.038	0.896	35	0.003
Control	0.231	35	0.000	0.792	35	0.000

Note: Lilliefors Significance Correction was applied to the Kolmogorov–Smirnov test.

Mann–Whitney U test (pretest) in Table 4 shows Asymp. Sig. (2-tailed) = 0.829 (> 0.05). This result indicates no significant difference between the experimental and control groups on the pretest. In other words, both groups had equivalent initial mathematical literacy.

Table 4. Mann–Whitney U Test Results for Pretest Scores (Experimental vs Control Groups)

Test Statistics

Statistic	Value
Mann–Whitney U	594.500
Wilcoxon W	1224.500
Z	-0.216
Asymp. Sig. (2-tailed)	0.829

Normality test (posttest) in Table 5 indicates that at least one group had a significance value below 0.05. This result means the posttest data did not meet the normality assumption. Therefore, the Mann–Whitney U test was used for the posttest comparison.

Table 5. Normality Test Results for Posttest Scores in the Experimental and Control Groups

Tests of Normality

Group	Kolmogorov–Smirnov (Lilliefors) Statistic	df	Sig.	Shapiro–Wilk Statistic	df	Sig.
Experimental	0.141	35	0.077	0.922	35	0.017
Control	0.176	35	0.008	0.921	35	0.015

Note: Lilliefors Significance Correction was applied to the Kolmogorov–Smirnov test.

Mann–Whitney U test (posttest) in Table 6 shows Asymp. Sig. (2-tailed) = 0.000 ($p < 0.001$). This result indicates a significant difference between the experimental and control groups after the intervention. The Z value was -5.128, which corresponds to a large effect size ($r = 0.61$), showing a strong practical impact of the intervention.

Table 6. Mann–Whitney U Test Results for Posttest Scores (Experimental vs Control Groups)

Test Statistics

Statistic	Value
Mann–Whitney U	180.000
Wilcoxon W	810.000
Z	-5.128
Asymp. Sig. (2-tailed)	0.000

Note: Grouping variable: Class.

Discussion

The findings indicate that students in the experimental and control groups began the study with comparable mathematical literacy levels. After the intervention, the experimental group demonstrated stronger mathematical literacy performance than the control group. This pattern suggests that the video-assisted 5E Learning Cycle model contributed positively to students' mathematical literacy compared with conventional instruction. This improvement is theoretically plausible because the 5E Learning Cycle organizes learning into engagement, exploration, explanation, elaboration, and evaluation (Unaenah & Rahmah, 2019). These stages encourage students to interpret information, generate strategies, justify reasoning, and reflect on solutions (Varoglu et al., 2023). Such learning conditions support the development of literacy-oriented competencies, including conceptual understanding, problem solving, applying mathematics in real-life contexts, and critical thinking (Liana, 2020). Learning videos likely strengthened these processes by providing more concrete representations and contextual examples, which help students connect mathematical ideas to meaningful situations and reduce ambiguity when constructing new concepts.

The observation evidence suggests that implementation quality improved across meetings. Early sessions faced time and classroom preparation constraints, which limited the completion of some 5E stages. In later sessions, the model was implemented more consistently, although the explanation stage still required stronger time allocation to ensure every group could present and discuss its reasoning (Khoitin et al., 2018). These findings indicate that the effectiveness of the 5E plus video approach depends on implementation fidelity, especially teachers' time management and orchestration of discussion so that students can externalize and refine their reasoning. Although the outcomes are encouraging, causal interpretation should remain cautious because the study used intact classes without random assignment. Several threats to internal validity may influence the results, including selection differences between classes, teacher effects, possible contamination across groups, and reactivity effects when the experimental group receives greater attention. In addition, the study has not reported the use of a validated implementation rubric and inter-observer reliability for the observation ratings. Without these controls, it is difficult to confirm that the differences fully reflect strong and consistent fidelity of the 5E plus video implementation.



Figure 3. The use of the 5E Learning Cycle Model with assistance Learning Videos in Class Experiment

From a practical perspective, these findings imply that teachers should design learning videos that align with lesson objectives and student readiness, manage instructional time so each 5E stage is completed as planned, and integrate explicit 5E guidance into worksheets so students know what to do, what to explain, and how to evaluate solutions. Teachers also need to scaffold students who are not yet accustomed to constructing concepts independently, particularly during exploration and explanation, so students do not rely on guessing or procedural mimicry. This study is consistent with prior evidence that the 5E Learning Cycle can improve mathematical literacy and learning outcomes (Aini et al., 2021) and that variations

of the 5E approach, including STEM-oriented implementations, can produce meaningful differences in student achievement (Salma et al., 2022). It also supports the view that the 5E Learning Cycle provides opportunities for students to actively construct knowledge, build conceptual understanding, and learn meaningfully through individual and group engagement (Suherman, 2018).

Conclusion

Based on the data analysis, this study shows that students who learned using the video-assisted 5E Learning Cycle model achieved higher mathematical literacy than students who learned through conventional instruction. The difference was statistically significant, indicating that implementing the 5E Learning Cycle with video support can enhance students' conceptual understanding, problem-solving, the use of mathematics in real-life contexts, and critical thinking skills. However, this conclusion should be interpreted in light of the study's limitations, including the quasi-experimental design and non-random sampling. Therefore, the generalization of the findings should be made cautiously. These results have practical implications, suggesting that mathematics teachers may consider using an enriched 5E Learning Cycle model supported by instructional videos to create more meaningful learning experiences and strengthen students' mathematical literacy.

This study also has several limitations. First, the supporting resources were limited, and producing instructional videos required considerable preparation time. Second, some of the videos were difficult to access because they were sourced from the internet, which may have disrupted the learning process. Therefore, future research is recommended to develop instructional videos independently and more systematically to ensure alignment with learning objectives and easier student access. Future studies may also explore more optimal integration between the 5E Learning Cycle model and video-based media to achieve stronger effects on students' mathematical literacy.

Conflict of Interest

The author declares no conflict of interest.

Authors' Contributions

A.S. contributed to understanding the proposed research idea and collecting the data. S.H. actively contributed to the development of the theoretical framework, methodology design, data organization and analysis, discussion of the findings, and approval of the final version of the manuscript. All authors confirm that they have read and approved the final version of this paper. The contribution proportions to the conceptualization, drafting, and revision of this manuscript are as follows: A.S.: 70%; and S.H.: 30%.

Data Availability Statement

The author declares that data supporting the results of this study will be made available by the corresponding author, [A.S.], upon reasonable request.

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Author Biographies

	<p>Annisa Stabita is a student and researcher in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Islam Riau. Email: stabitaannisa@gmail.com</p>
	<p>Sari Herlina is a lecturer in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Islam Riau. She earned her Doctoral degree in Mathematics Education from Universitas Pendidikan Indonesia. Her areas of expertise include mathematics education, problem-based learning, and learning assessment. Her academic activities include teaching, research, and community service. Email: sariherlina99@edu.uir.ac.id</p>