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Ethno-STEAM based ReMIS (read, make video, identify, solve problem) learning model to improve critical thinking abilities and digital literacy

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Abstract

This study aims to describe the effect of the Ethno-STEAM-based ReMIS learning model on students' critical thinking and digital literacy skills. The primary issue of this study is the low level of critical thinking and digital literacy skills in the technological era, which hinders students from analyzing information and adapting to digital-based learning. The method used in this study is a quantitative, quasi-experimental design that directly tests the effect of the Ethno-STEAM-based ReMIS learning model on students' critical thinking and digital literacy skills, employing a pretest and posttest non-equivalent control group design. The research sample employed a purposive sampling method, comprising 26 students from class 2024A and 24 students from class 2024B. The results showed that the application of the Ethno-STEAM-based ReMIS learning model was significantly effective in improving students' critical thinking skills, with an average increase of 79.85 students and an N-Gain of 0.459. The Ethno-STEAM-based ReMIS learning model significantly improved students' digital literacy with an average increase of 77.46 and an N-Gain of 0.418. The implementation of the Ethno-STEAM-based ReMIS learning model represents a significant learning innovation in higher education, capable of enhancing the quality of students' science learning outcomes through a culturally informed approach.

Keywords: critical thinking; digital literacy; ethno-STEAM; learning model; ReMIS

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I. Introduction

Current developments and advancements in science, technology, and digital technology are bringing about profound changes in the fabric of human life, including education (Saija, Rahayu, Fajaroh & Sumari, 2022). Education must be able to develop rapidly, innovate, and transform to produce graduates who are adaptable and ready to face global challenges and utilize technology optimally (Hollenstein & Vogt, 2024).

A technological approach to education opens up opportunities to improve student learning experiences, standards, and participation (Reddy, Sharma & Chaudhary, 2020) Education must foster the mastery of critical thinking skills and digital literacy in students, enabling them to adapt to and face technological and digital advancements in the 21st century (Berta, 2021).

Critical thinking skills are students' skills in receiving information, analyzing ideas or concepts related to problems, and generating solutions (Zikrullah, 2024) (Nisrina, Saputra & Efendi, 2024). Students need critical thinking skills to analyze information in depth, evaluate alternatives, and provide effective solutions to problems in everyday life. Digital literacy is a skill that enables students to develop proficiency in digital technology. Digital literacy is a student's ability to obtain, interpret, and use learning information through computers and digital network sources (Ismail, Supeno & Rusdianto, 2024). Student learning success is largely determined by factors related to utilizing technology and the internet to search for information (Fadila, Nadiroh, Juliana, Zulfa & Ibrahim, 2021). Digital literacy can enhance students' knowledge and critical thinking skills, as well as their ability to manage various digital platforms that are currently evolving (Setiadi, Alia & Nugraha, 2022).

Initial observations conducted in the Mathematics Education Study Program at the University of West Sulawesi indicate that students' critical thinking skills and digital literacy remain very low. In 2023, students' critical thinking skills fell into the low category, with a percentage of 67% (Nuryamsi & Rahman, 2023), and their digital literacy was at the basic level (Irfan, 2023). This low level of critical thinking and digital literacy is due to a lack of innovation and creativity in implementing mathematics learning models in the classroom. Learning models tend to be less student-focused, resulting in less active learning and lower student learning outcomes.

Students tend to be inactive and unable to provide analysis and argumentation during discussion sessions. Likewise, students' digital literacy remains relatively low (Afrina & Zulaikha, 2024). Students have limited mastery of digital technology and its applications for educational purposes. Students tend to use the internet directly as academic reference material without considering sources (Raj, Khanal, Prasad, Chapai & Prasad, 2025), and smartphones are more often used by students for social media and gaming (Sekarrini, Mekar & Bogor, 2020) (Ririen & Heriasman, 2021).

The implementation of the ReMIS (Read, Make Video, Identify, Solve Problem) model is crucial for improving the quality and competitiveness of West Sulawesi University graduates. The ReMIS learning method is an interactive, innovative, and project-based approach that enhances student engagement (Sholihah, Zubaidah, Mahanal & Listyorini, 2025). This learning integrates project-based learning with technology and digital learning applications, including video production (Wahyuni & Irmawati, 2024).

ReMIS learning stimulates the development of students' critical thinking skills through the stages of problem identification and problem solving. Ethno-STEAM is a learning approach that integrates local culture with STEAM concepts Husna, Azhari, Wahyuni, Nabila & Wandira, 2024). The Ethno-STEAM approach is a learning innovation that can develop students' critical thinking skills and digital literacy through real-life situations involving local culture and scientific concepts (Sumarni & Kadarwati, 2025). Learning that approaches local wisdom in the STEAM concept can create student-centered learning and increase interactions between lecturers and students (Hähkiöniemi et al., 2022).

Although previous research on the ReMIS model has been conducted, most studies have focused solely on project-based learning and the use of digital technology without directly linking them to the local cultural context. On the other hand, studies on Ethno-STEAM have focused more on integrating culture with science concepts, but have not systematically incorporated the distinctive stages of ReMIS—Read, Make Video, Identify, Solve Problem—as a comprehensive learning strategy (Laakso, Korhonen & Hakkarainen, 2021). An unfilled research gap exists: how to integrate a Mandar culture-based ethnopedagogy approach with the ReMIS stages

within a STEAM framework to improve students' critical thinking and digital literacy skills.

Furthermore, previous research tends to focus on critical thinking skills or digital literacy only partially. However, observations at the University of West Sulawesi indicate that both aspects remain at a low level. Students are often unable to provide in-depth analysis and argumentation in discussions, despite their limited digital literacy, which primarily involves using the internet as a reference without considering the validity of sources. This situation highlights the need for a learning model that addresses two key issues simultaneously: low critical thinking skills and weak digital literacy.

Based on the above problems, researchers innovated by implementing the ReMIS learning model based on local culture (Mandar) STEAM. Highly relevant, contextual, and project-based learning that improves students' critical thinking skills and digital literacy. This study aims to analyze the effectiveness of improving students' critical thinking skills and digital literacy by implementing the ReMIS (Read, Make Video, Identify, Solve Problem) learning model based on Ethno-STEAM to improve critical thinking skills and digital literacy. This research is expected to make a positive contribution to improving the quality of education and preparing students as superior human resources in line with the vision and mission of "Towards a Golden Indonesia 2045".

II. Research Method

The research was a quasi-experimental study. The data analysis design employed was a pretest-posttest non-equivalent control group design. To evaluate and understand the skills of the treatment and control groups, the study was designed to divide the students into two groups: the 2024A and 2024B cohorts. The research design is presented in Table 1 below.

Table 1. Research design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

The group that received treatment in this study was the group that implemented the Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model, whereas the comparison group implemented the direct ReMIS (Read, Make Video, Identify, Solve Problem) model. The study was conducted in the Mathematics Education Study Program, Faculty of Teacher Training and Education, West Sulawesi University. The population in this study consisted of all students in the Mathematics Study Program at FKIP, West Sulawesi University. The determination of the research sample used a purposive sampling method consisting of 2 groups, namely students from Class 2024A with a total of 26 people and students from Class 2024B with a total of 24 people.

The variables observed in this study consisted of two things: students' critical thinking skills and digital literacy, which served as the dependent variables. The independent variables were the Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model and the direct ReMIS (Read, Make Video, Identify, Solve Problem) model. Data collection was conducted using instruments designed for the research purposes: a multiple-choice objective test aimed at measuring students' critical thinking skills and a questionnaire test to measure students' digital literacy skills.

The testing instrument in this study consisted of two main parts: a critical thinking skills test and a digital literacy questionnaire. The critical thinking skills test was designed in the form of objective questions with indicators that refer to students' abilities to analyze, evaluate, and formulate solutions to mathematical problems. Each question item was developed based on Ennis's critical thinking dimensions, which include the ability to provide simple explanations, build basic skills, draw conclusions, provide further explanations, and organize strategies and tactics effectively. For example, items in the "provide simple explanations" dimension require students to identify relevant arguments in a geometry problem. In contrast, the "draw

conclusions" dimension measures students' ability to form logical inferences from available data. Content validation was conducted by three lecturers specializing in mathematics education to ensure the suitability of the indicators to the learning objectives.

Meanwhile, a digital literacy questionnaire was developed to measure students' ability to access, evaluate, produce, and communicate digital information ethically and effectively. This instrument is divided into four main dimensions: (1) digital information access, which assesses students' ability to use devices and applications to find learning resources; (2) information evaluation, which measures the ability to distinguish valid information from hoaxes or non-credible sources; (3) digital content production, which assesses students' ability to create videos, presentations, or digital materials relevant to learning; and (4) digital communication, which measures students' skills in interacting responsibly using digital platforms. Each dimension is represented by several items with a Likert scale, ranging from "strongly disagree" to "strongly agree," thus allowing for quantitative analysis of students' digital literacy levels.

The test validation process included item validity, content validation, and question reliability, which were conducted prior to the instrument's field application for data collection. Content validation was conducted by three Mathematics Education lecturers who are experts in the field of mathematics. Test reliability testing in this study used the Cronbach Alpha method.

The data collected through the research instrument will be analyzed and processed using descriptive analysis techniques that aim to provide an overview and improvement of students' critical thinking and digital literacy skills by providing treatment of the Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model and the direct ReMIS (Read, Make Video, Identify, Solve Problem) model. The measurement of the average increase in students' abilities before and after the implementation of the learning model utilises the normalized gain formula (N-Gain). The inferential analysis technique in the study uses the MANOVA technique or multivariate analysis of variance, whose calculations are assisted by SPSS version 25 using Windows at a significance level of 0.05.

III. Results and Discussion

This study analyzes the improvement of student abilities by implementing the ReMIS (Read, Make Video, Identify, Solve Problem) learning model using an Ethno-STEAM approach in the experimental class through four learning stages: 1) the read stage, where students read learning materials related to the subject through a local cultural approach; 2) the make a video stage, where students create an explanatory video related to the subject; 3) the identify stage, where students identify problems related to the subject; and 4) the solve problem stage, where students solve problems related to the subject using analysis and critical thinking. The control class implemented the direct ReMIS (Read, Make Video, Identify, Solve Problem) learning model. The treatment in this study was conducted over four meetings.

Based on the implementation of the learning model, descriptive data on student abilities were obtained, as shown in Table 2 below.

Table 2. Critical thinking data of students in the experimental and control groups

Statistic	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Sample	26	26	24	24
Average	63,08	79,85	56,50	75,67
Std. Deviation	9,28	7,37	9,53	6,45
Max Value	80	96	76	88

Based on the data presented in Table 2 above, the average critical thinking ability of students in the experimental class before the treatment was 63.08, and after the treatment, it was 79.85. Implementing the ReMIS (Read, Make Video, Identify, Solve Problem) learning model with the Ethno-STEAM approach

increased the average critical thinking ability of students to 79.85. Implementing the direct ReMIS (Read, Make Video, Identify, Solve Problem) learning model in the control class before the treatment averaged 56.50 and after the treatment averaged 75.67, increasing to 75.67.

Measuring the improvement in critical thinking skills of students in the experimental and control classes is crucial for determining the effectiveness and changes in abilities after receiving the ReMIS (Read, Make Video, Identify, Solve Problem) learning model, using the Ethno-STEAM and direct ReMIS approaches. This measurement was performed using normalized gain (N-Gain). The results of the N-Gain test calculations for students' critical thinking abilities are presented in Table 3 below. The N-Gain scores provide a quantitative overview of the significant improvement in students' critical thinking skills after the intervention. These results also serve as empirical evidence to compare the impact of the Ethno-STEAM-integrated ReMIS model versus the conventional ReMIS approach.

Table 3. Average of the critical thinking N-Gain test of the experimental and control classes

Group	N	Average	Category
Experiment	26	0.45	Medium
Control	26	0.43	High

Based on the data presented in Table 3 above, the average critical thinking skills of students in the group treated with the ReMIS (Read, Make Video, Identify, Solve Problem) learning model using the Ethno-STEAM approach were superior to those in the group treated with the direct ReMIS (Read, Make Video, Identify, Solve Problem) learning model. In the experimental group, the average N-Gain score was 0.45, categorized as moderate, while in the control group, the average N-Gain score was 0.43, categorized as moderate.

The implementation of the ReMIS (Read, Make Video, Identify, Solve Problem) learning model using the Ethno-STEAM approach in the experimental class and the direct ReMIS learning model in the control class significantly impacted students' digital literacy skills. The results of students' digital literacy skills before and after the implementation of the learning models are shown in Table 4 below.

Table 4. Literacy digital data of students in the experimental and control groups

Statistic	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Sample	26	26	24	24
Average	59,92	77,46	55,17	73,83
Std. Deviation	3,77	4,36	5,53	4,08
Max Value	66	86	64	82

Based on the data presented in Table 4 above, the average digital literacy score of students in the experimental class before the treatment was 59.92, and after the treatment, it was 77.46. Implementing the ReMIS (Read, Make Video, Identify, Solve Problem) learning model with the Ethno-STEAM approach increased the average critical thinking skills of students to 77.46. Implementing the direct ReMIS (Read, Make Video, Identify, Solve Problem) learning model in the control class before the treatment was 55.17 and after the treatment was 73.83, resulting in an increase in the average ability to 73.83.

Measuring the improvement in digital literacy of students in the experimental and control classes is crucial for determining the effectiveness and changes in abilities after receiving the ReMIS (Read, Make Video, Identify, Solve Problem) learning model, using the Ethno-STEAM and direct ReMIS approaches. This measurement was performed using normalized gain (N-Gain). The results of the N-Gain test calculations for students' digital literacy are presented in the table below.

The N-Gain score reflects the extent to which students' digital competencies improved after the learning intervention. This competency encompasses the ability to search for, evaluate, create, and communicate information using

digital tools. By comparing N-Gain scores between the two groups, researchers can identify which approach resulted in more significant improvements in students' digital literacy. This analysis also provides an empirical basis for designing more effective and sustainable digital learning strategies.

Table 5. The average of the literacy digital N-Gain test of the experimental and control classes

Group	N	Average	Category
Experiment	26	0.44	Medium
Control	26	0.41	High

Based on the data presented in Table 5 above, the average critical thinking ability scores of students in the group treated with the ReMIS (Read, Make Video, Identify, Solve Problem) learning model using the Ethno-STEM approach were superior to those in the direct ReMIS (Read, Make Video, Identify, Solve Problem) learning model. In the experimental group, the average N-Gain score was 0.44, categorized as moderate, while in the control group, the average N-Gain score was 0.41, categorized as moderate.

Normality testing was conducted in this study to determine whether the data on students' critical thinking and digital literacy skills were normally distributed. This test was conducted on group data before and after implementing the ReMIS (Read, Make Video, Identify, Solve Problem) learning model using the Ethno-STEAM approach in the experimental class and direct ReMIS in the control class. The Shapiro-Wilk test was used to test normality using SPSS version 25 for Windows. The results of the normality test are presented in Table 6 below.

Table 6. Normality test result

	Critical Thinking		Literacy Digital	
	Experiment	Control	Experiment	Control
Sig	0,579	0,707	0,344	0,408
Sig Level (a)	0,05			
Conclusion	Both data are normal		Both data are normal	

Based on the data in Table 6 above, the homogeneity test for students' critical thinking skills showed a significance value of 0.579 in the experimental class and 0.707 in the control class, thus concluding that the data exhibited homogeneous variance. The homogeneity test for students' digital literacy data in the experimental class yielded a value of 0.344 and a value of 0.408 in the control class. Both results are greater than the α value of 0.05, thus concluding that the variance of students' digital literacy data in the experimental and control classes is homogeneous.

A correlation test was conducted to examine the relationship between the dependent variables, namely critical thinking skills and students' digital literacy. The results of the correlation test for critical thinking skills and digital literacy are presented in Table 7 below.

Table 7. Results of the correlation test of students' critical thinking skills and digital literacy

Group	Sig. Level	Result
Experiment	0.972	Not Significant
Control	0.106	Not Significant

The correlation test results obtained a significance value of 0.972 in the experimental class and 0.106 in the control class. Both data points exceeded the α significance level of 0.05, thus concluding that there is no correlation between students' critical thinking skills and digital literacy as the dependent variable. These results meet the requirements for hypothesis testing using multivariate MANOVA analysis.

The first hypothesis tested in this study using MANOVA concerns the effect of the Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model on students' critical thinking skills in geometry. The test results yielded an F-value of 6.106 with a significance level of 0.017. This result indicates that the significance level is less than 0.05 (0.017 < 0.05), thus H0 is rejected, and H1 is accepted. Based on these data, the implementation of the ReMIS (Read, Make Video, Identify, Solve Problem) learning model, based on Ethno-STEAM, has a significant influence on students' critical thinking skills in learning mathematics, particularly in the context of geometry material.

The critical thinking skills of students in the experimental class, which was treated with the Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model, had an average score of 79.85, significantly higher than the average score of 75.67 in the control class using direct ReMIS. The ReMIS learning model, with its Ethno-STEM approach, fosters understanding and analysis of science and technology phenomena through students' local cultural values and practices. Learning emphasizes STEAM-based science solutions by leveraging the local cultural experiences of the students.

This aligns with research conducted by Prabawati, Yamtinah, Bramastia & Sidiq (2023), which found that Ethno-STEAM-based science learning significantly improves students' critical and creative thinking skills, one of the 4C skills required in the independent curriculum. Learning through the Ethno-STEAM approach fosters critical thinking skills by providing frequent opportunities to explore and express opinions and ideas through critical, receptive, collaborative, and creative thinking (Sumarni & Kadarwati, 2020). Ethno-STEAM based learning improves the ability to think cause and effect, predict logical results, analyze data from various perspectives, evaluate and create (Martawijaya, Rahmadhanningsih, Swandi & Hasyim, 2023).

Learning activities that connect temporal contexts with scientific phenomena that students can observe and experience, without focusing solely on the topic and learning material, are highly effective in improving students' critical thinking skills (Sholihah et al., 2025). Learning can minimize the gap between abstract scientific knowledge and material by approaching cultural scientific issues through learning that relates to the realities of students' lives (Shoba, Hardianti & Pamelasari, 2023).

The second hypothesis in this study is the effect of the Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model on students' digital literacy skills in Geometry. Based on the calculations, the F-value was 4.517 with a significance level of 0.039. The results of the hypothesis calculation for students' digital literacy skills showed that the value was smaller than $\alpha = 0.05$; therefore, H0 was rejected, and H1 was accepted. It can be concluded that the implementation of the ReMIS (Read, Make Video, Identify, Solve Problem) learning model, based on Ethno-STEAM, has a significant influence on improving students' digital literacy skills.

The Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model is a pedagogical innovation that combines problem-based learning, digital technology, and local wisdom into a unified learning experience. An understanding of culture and society enables digital literacy, capable of creating, communicating, and acting ethically regarding what, how, and when to use digital technology effectively to achieve learning objectives (Shatila, Aranega, Soga, Lara & Beatriz, 2025).

Learning using the stages of technology implementation (making a video) produces meaningful and contextual digital content. Similar research conducted by Zan & Asrizal (2024), on the use of Ethno-STEAM-based digital teaching materials enriched with AR can improve students' digital literacy skills. Critical, creative, and contextual use of technology will enrich the digital science learning experience. Digital literacy in learning encompasses not only the skill of operating learning devices and applications, but also the ability to access, evaluate, produce, and communicate digital information effectively and responsibly (Moravec, Hynek, Gavurova & Rigelsky, 2024).

Students' mastery of digital literacy skills significantly contributes to the learning process (Hutapea et al., 2023). The involvement of digital technology in learning enriches students' understanding and mastery of digital literacy. In the era of the Industrial Revolution 4.0, learning using a digital technology approach contributes 40% to improving the quality of the learning process and students' digital literacy skills (Akbar, 2025).

The third hypothesis examines the effect of implementing the Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model on the critical thinking and digital literacy skills of students in the Mathematics Education Study Program, specifically in the geometry course. The results of the hypothesis test showed an F-value of 7.012. With a significance level of 0.024, H0 is rejected, and H1 is accepted. Based on this data, it can be concluded that the implementation of the ReMIS (Read, Make Video, Identify, Solve Problem) learning model, based on Ethno-STEAM, significantly influences the critical thinking skills and digital literacy of students in the Mathematics Education Study Program, particularly in the geometry material.

Improving students' digital literacy has a significantly positive impact on the development of their critical thinking skills. Students who navigate the digital world effectively and carefully are not only technology users but also reflective and analytical thinkers. Strong digital literacy skills enable them to access, evaluate, and utilize information wisely and responsibly. Similar research conducted by Putranto, Gandariani, Siregar & Khaerudin (2025) on the relationship between digital literacy and critical thinking in the context of Society 5.0 found that students with high digital literacy skills tend to have better reasoning skills and can understand the social and ethical context of the information they receive.

These results are supported by research conducted by Dhewi & Ningrum (2021) on digital literacy strategies as a means of strengthening critical thinking in journalism students. They concluded that using digital media effectively encourages students to think more critically in solving learning problems and seeking solutions. Students will be able to express their opinions effectively, respond to and accept feedback, and refine arguments collaboratively. A strong mastery of digital literacy will enable them to develop into active learners and creative problem solvers.

IV. Conclusion

Based on the results of the discussion, data calculations, and hypothesis testing conducted in this study, the following conclusions can be drawn: first, there is a significant effect of the Ethno-STEAM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model on critical thinking skills in the Mathematics Education Study Program, West Sulawesi University. There was an increase in the average critical thinking skills of students before and after implementing the learning model.

Second, there is a significant effect of the Ethno-STEAM-based ReMIS (Read, Make, Video, Identify, Solve Problem) learning model on digital literacy skills in the Mathematics Education Study Program at West Sulawesi University. Third, there is a significant effect of the Ethno-STEM-based ReMIS (Read, Make Video, Identify, Solve Problem) learning model on critical thinking and digital literacy skills.

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Hopefully, the contributions of all parties involved can be part of a joint effort to improve the quality of educational research in Indonesia,

particularly in the field of mathematics education. Collaboration across disciplines and institutions is expected to enrich perspectives and broaden the impact of research findings.

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