JPII 13 (4) (2024) 583-596

Jurnal Pendidikan IPA Indonesia

https://journal.unnes.ac.id/journals/jpii

THE INFLUENCE OF SCIENTIFIC-BASED NUMERACY LITERACY TEACHING MATERIALS ON STUDENTS' MOTIVATION AND HIGHER-ORDER THINKING SKILLS

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DOI: 10.15294/jpii.v13i4.13655

Accepted: September 14th, 2024. Approved: December 29th, 2024. Published: December 30th 2024

ABSTRACT

This research aims to analyze the influence of scientific-based numeracy literacy teaching materials on students' motivation and higher-order thinking abilities. This quantitative research uses a quasi-experiment method with a nonequivalent control group design. Sampling used a purposive sampling technique. The instruments used were motivational questionnaire sheets and higher-order thinking skills tests. The paired sample t-test was used to analyze the data. The findings indicate a significant difference in the average posttest scores between the experimental and control groups, with a significance value of 0.000<0.005 and a mean difference of 18.06 (66.00 - 47.94) between the two groups. The confidence interval for the difference ranged from -36.959 to -30.354. There is a significant (real) difference between students' average motivation score and higher-order thinking skills in the experimental and control groups using scientific-based numeracy literacy teaching materials. It can be concluded that the scientific-based numeracy literacy teaching materials influence students' learning motivation and higher-order thinking skills.

Keywords: scientific-based numeracy literacy; teaching materials; motivation; higher-order thinking skills

INTRODUCTION

A scientific approach is one of the most important skills that students must develop. Students with scientific approach skills can apply the knowledge learned, strengthen concepts, and train creativity and communication skills to solve problems in everyday life (Eek & Stigmar, 2024; Kanphukiew & Nuangchalerm, 2024; Novita et al., 2023; Wisanti et al., 2024). The scientific approach plays an important role in everyday life. In the 21st century, individuals with scientific knowledge and an understanding of current technological issues are needed (Kholifah et al., 2023; Kholili et al., 2024; Dašić et al., 2024). Although the scientific approach to education offers many benefits, it is not free from various problems in its implementation (Valladares, 2021).

A common problem in implementing a scientific approach is the limited time in the curriculum to fully implement the scientific approach (Jumadi et al., 2021; Prasetyono et al.,

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2021). The learning process through this approach requires a long time because students must go through various stages, such as observation, experimentation, and communication. However, with the demand to complete the curriculum within a specific time, teachers often feel pressured to speed up the learning process, which in turn can reduce the quality of the scientific approach itself (Glüer-Pagin & Spectre, 2024; Kanphukiew & Nuangchalerm, 2024).

Students' different skills and interests can also be a challenge. The scientific approach requires students to actively participate, think critically, and develop problem-solving skills (Garcés-Gómez et al., 2024; Hernawati et al., 2018; Sa-Ngiemjit et al., 2024). However, not all students are equally prepared or interested in this method. Students with less interest in science or limitations in analytical thinking skills may find it difficult to follow the learning based on the scientific approach (Darwin et al., 2024; Shofiyah et al., 2024). The difference can lead to inequality in students' learning outcomes.

The concept of numeracy literacy, which includes the ability to understand and apply concepts in everyday life, has become one of the essential competencies that every individual must have, especially in an academic environment (Maharani & Dasari, 2024). Many students still experience difficulties in understanding numeracy concepts in depth and integrating them with scientific knowledge. This difficulty often results in low learning motivation and limitations in higher-order thinking skills, such as analysis, evaluation, and synthesis (Glüer-Pagin & Spectre, 2024).

Although recognized as a practical approach to improving students' critical and analytical thinking skills, implementing scientific-based numeracy literacy teaching materials is not free from various challenges. One of the main challenges is the lack of teachers' understanding and skills in designing and implementing teaching materials that align with the scientific approach's principles (Kholili et al., 2024; Daši□ et al., 2024). Teachers often have not received adequate training, so they struggle to integrate important elements of this approach, such as observation, experimentation, and data analysis, into their teaching materials. In addition, limited resources and time are also hindering factors, where teachers face the reality of a crowded curriculum and limited teaching aids or supporting technology. Some teachers are still comfortable with traditional teaching methods and are reluctant to switch to new, more interactive, and discovery-based methods, challenging resistance to change (Darwin et al., 2024; Shofiyah et al., 2024). This reluctance suggests that scientific-based numeracy literacy teaching materials should be implemented. Holistic support is needed, including teachers' training and adequate resources (Setiyani et al., 2024).

The teaching materials must contain the entire material systematically, have easy-to-understand language, and have practice questions that guide students to think at a higher level and increase their motivation. Students must also study teaching materials independently or with minimal guidance from the teachers (Manurung et al., 2023; Ong & Quek, 2023). The background of this research stems from the importance of developing teaching materials that can support increased learning motivation and higher-order thinking skills of students in the modern era. Another aspect that needs to be considered is how this scientific approach supports differentiation of learning, which allows teaching materials to be tailored to students' different ability levels. Thus, students with difficulty understanding certain concepts can be given additional support through a more visual or practical approach, while more advanced students can be given additional challenges that encourage them to think more deeply. This differentiation is important to ensure that every student, regardless of ability level, gets the opportunity to develop their higher-order thinking skills.

Motivation is one of the driving forces within a person to gain skills, experience, and knowledge in learning activities (Adisel et al., 2024; Cooke et al., 2021; Guosheng et al., 2024; Lo et al., 2022). Some indicators of motivation to learn are having the desire to achieve success, having the desire to learn, preferring to work alone, enjoying participating in learning activities, being diligent in studying and doing assignments (Malkoc & Dal, 2021; Syahmani et al., 2023). Motivation is an essential thing that students need in the learning process (Kuswanto & Anderson, 2021; Tambunan et al., 2021; Tanti et al., 2020; Thoyib et al., 2024). Learning motivation is the overall driving force within students, giving rise to learning activities to achieve learning objectives (Apoko & Cahyono, 2024; Gunobgunob-Mirasol, 2019). Another opinion states that learning motivation is interpreted as encouraging students to learn or want to carry out learning activities (Amin et al., 2022; Fischer & Brückner, 2024; Glüer-Pagin & Spectre, 2024).

Learning motivation is also the urge to apply cognitive and affective schemes to improve learning outcomes (Lockl et al., 2021; McGrew, 2022; Wei et al., 2021). Motivation has an important function in learning because it determines the intensity of learning efforts carried out by students (Trigueros et al., 2020; Zulherman et al., 2023). The importance of motivation can encourage students to learn so that effective learning occurs, which will ultimately improve their learning achievement (Chue & Nie, 2016; Filgona et al., 2020; Vo et al., 2022; Suárez-Mesa & Gómez, 2024).

Higher-order thinking skills are not just skills that rely on memory but require other skills, such as critical and creative thinking and problem-solving skills (Hujjatusnaini et al., 2022; Kanphukiew & Nuangchalerm, 2024; Maryani et al., 2022; Yerimadesi et al., 2023). In critical thinking skills, higher-order thinking skills are needed in receiving various types of information. Meanwhile, in creative thinking skills, higher-order thinking skills are needed to make decisions in complex situations (Samadi et al., 2024; Supratman et al., 2023). Higher-order thinking skills are a way of thinking that is no longer just memorizing verbally but thinking analytically, synthesizing, associating, and drawing conclusions in creating creative and productive ideas (Afikah et al., 2022; Lee et al., 2024; Setiawan et al., 2021).

Another problem is the lack of integrating of the scientific approach in numeracy literacy teaching materials in higher education. The scientific approach can help students develop a more profound and contextual understanding of numeracy concepts and encourage them to think critically and creatively in solving problems (Eek & Stigmar, 2024; Garcés-Gómez et al., 2024; Kanphukiew & Nuangchalerm, 2024). Thus, there is an urgent need to explore the effect of scientific-based numeracy literacy teaching materials on students' learning motivation and higher-order thinking skills to find more effective learning strategies suitable for the education challenges in this era of globalization.

Scientific-based teaching materials are designed to bridge this gap by integrating the scientific approach into the numeracy literacy learning process. This approach focuses not only on knowledge transfer but also on the development of higher cognitive abilities, such as problem-solving, critical thinking, and decision-making based on data and facts (Alarcon et al., 2023; Avikasari et al., 2018; Rokhimawan et al., 2022). Meanwhile, this research aims to analyze the influence of scientific-based numeracy literacy teaching materials on students' motivation and higher-order thinking skills (HOTS).

METHODS

The research was carried out on students at Universitas Islam Negeri Syekh Ali Hasan Ahmad Addary Padangsidimpuan. The research method used is a quasi-experiment with a nonequivalent control group design (Campbell & Stanley, 1963). The research sample is class A as the experimental class and class B as the control group. The experimental group was given treatment using scientific-based numeracy literacy teaching materials, while the control group did not use scientific-based numeracy literacy teaching materials. It is important to note that quasi-experimental designs have limitations, such as potential confounding variables and issues with internal validity. The quasi-experimental design used in this study has limitations, particularly internal validity. Without complete randomization of the research subjects, there is a more significant potential for confounding variables to emerge, which could affect the study results. Another limitation is the difficulty isolating the factors responsible for the observed changes in students' motivation and higher-order thinking skills. The results of this study still make an important contribution to the literature, but interpretation of the findings must consider the design's limitations.

Although this study utilized a quasi-experimental design, which offers advantages such as comparing control and experimental groups directly, some limitations are inherent. One of the main limitations is the potential presence of confounding variables that may affect the study results. These variables may be environmental factors, differences in students' backgrounds, or differences in teachers' experiences, which can be challenging to fully control for in a quasi-experimental setting. In addition, internal validity is a challenge in quasi-experimental research. This design does not involve complete randomization in forming experimental and control groups, so the possibility of selection bias cannot be ignored. This may affect the conclusions drawn regarding the cause-and-effect relationship between science-based teaching materials and students' learning outcomes.

It is important to provide a more detailed explanation of these limitations and how the researcher attempted to minimize their impact. For example, efforts such as matching the experimental and control groups' baseline characteristics or using reliable and valid measurement instruments need to be explained. An in-depth understanding of these limitations not only provides methodological clarity but also assists the reader in interpreting the research results more critically. Thus, although the quasi-experimental design has specific weaknesses, utilizing science-based numeracy literacy teaching materials still provides a promising opportunity to improve students' motivation and higher-order thinking skills, as long as the influence of external variables can be well managed.

The data collection techniques used are test techniques (pretest and posttest) and non-test techniques (observation sheets, questionnaires, and documentation). Before treatment, both classes were given a pretest to determine students' basic motivational abilities and higher-order thinking skills. After treatment, both groups were given a posttest to determine the extent of students' motivation and higher-order thinking skills. Hypothesis testing used ANOVA with the help of SPSS 25 software with a significance level 0.05. Research procedures include planning, implementation, and data analysis. The design of this research can be seen in Table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_1	X_2	O_2

The treatment for the experimental group was in the form of learning using scientific-based numeracy literacy teaching materials = X_1. The treatment for the control group was in the form of learning that did not use scientific-based numeracy literacy teaching materials = X_2, Pretest (initial test before treatment) = O_1, and Posttest (final test after treatment) = O_2.

A longitudinal approach, where research is conducted over a more extended period, will provide a deeper understanding of whether the positive effects found (for example, increased motivation or HOTS) will persist in the long term or whether they are temporary. Using longitudinal data can help researchers see if there is a decrease or increase in students' motivation and ability after a particular time, thus providing a more comprehensive picture of the sustainability of learning outcomes. A longitudinal approach will allow researchers to track students' progress over time and see how other factors, such as changes in learning methods, school environment, or external support, may affect the outcomes achieved. It will also help identify whether there is an adaptation or decline in motivation and higher-order thinking skills later in life. Thus, longitudinal research can provide a more comprehensive picture of the effectiveness and sustainability of teaching materials, providing more appropriate recommendations for long-term use in education.

RESULTS AND DISCUSSION

Based on the results of research carried out on students at Universitas Islam Negeri Syekh Ali Hasan Ahmad Addary Padangsidimpuan, data on students' motivation and higher-order thinking skills were obtained. The research data is described in detail as follows. 1. Normality Test of Students' Learning Motivation Data

Table 2. Normality Test

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	df	Sig.
Motivation	Pretest Experimental	.066	32	.200*	.976	32	.684
	Posttest Experimental	.065	32	.200*	.976	32	.663
	Pretest Control	.071	32	.200*	.975	32	.643
	Posttest Control	.073	32	.200*	.971	32	.520

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 2 shows that the Sig of the experimental group pretest was 0.684> 0.05, and the Sig of the experimental group posttest was 0.663>0.05. In the control group, the Sig of the pretest was 0.684 > 0.05, and the Sig of the posttest was 0.529 > 0.05. These results show that the data normality test for the experimental and control groups has a normal distribution.

2. Homogeneity Test of Students' Learning Motivation Data

Table 3. Homogeneity Test

		Levene Statistic	df1	df2	Sig.
Motivation	Based on Mean	.022	1	62	.881
	Based on Median	.011	1	62	.917
	Based on Median and with adjusted df	.011	1	61.855	.917
	Based on trimmed mean	.015	1	62	.902

Table 3 shows that the significance value (Sig.) of the higher-order thinking skills is 0.811. Because of the Sig value 0.811>0.05, the variance of students' learning motivation data in the experimental and control groups is homogeneous.

3. Paired Sample T-Test Results of Students' Learning Motivation Data

Table 4. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest Experimental	62.09	32	12.992	2.297
	Posttest Experimental	66.09	32	13.081	2.312
Pair 2	Pretest Control	58.41	32	12.979	2.294
	Posttest Control	64.19	32	13.150	2.325

Table 4 and Figure 1 show that the total data for the experimental group is 32 students, and the control group is 32 students. The average motivation score for the experimental group posttest was 66.09, while for the control group posttest, it was 64.19.

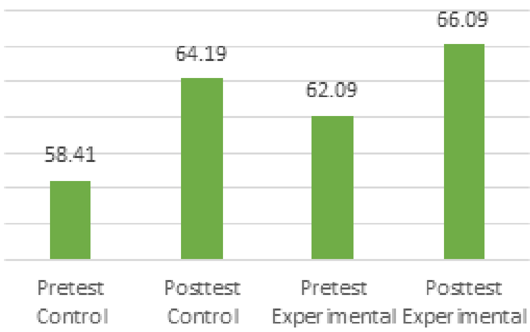

Figure 1. Difference in Students' Average Learning Motivation

Thus, descriptive statistics conclude that there is a difference in the average learning motivation of students in the experimental and control groups using scientific-based numeracy literacy teaching materials.

Table 5. Paired Samples T-Test

				95% Confidence Interval of the Difference		
		Mean	Std. Deviation	Lower	Upper	Sig. (2-tailed)
Pair 1	Pre-Post Experiment	-4.000	.508	-4.183	-3.817	.000
Pair 2	Pre-Post Control	-5.781	1.039	-6.156	-5.407	.000

Based on Table 5, the Sig value (2-tailed) is 0.000 < 0.05. Then, as is the basis for decision-making in the Paired sample t-test, it can be concluded that Ho is rejected and Ha is accepted. Thus, there is a significant (real) difference between the average learning motivation of students in the experimental and control groups using scientific-based numeracy literacy teaching materials. Furthermore, the "Mean Difference" value is 1.9. This value shows the difference between the average posttest score for the experimental and control groups, or 66.09-64.19 = 1.9, and the difference is -4.183 to -3.817 (95% Confidence Interval of the Difference Lower Upper).

4. Normality Test of Students' Higher-order Thinking Skills

Table 6. Normality Test

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Class	Statistic	Df	Sig.	Statistic	Df	Sig.
Higher-order Thinking	Pretest Experimental	.122	32	.200*	.979	32	.760
	Posttest Experimental	.140	32	.110	.958	32	.250
	Pretest Control	.145	32	.083	.940	32	.076
	Posttest Control	.090	32	.200*	.970	32	.498

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on Table 6, the Sig of the experimental class pretest was 0.760 > 0.05, and the Sig of the experimental class posttest was 0.250 > 0.05. Meanwhile, in the control class, the Sig value for the pretest was 0.76 > 0.05, and the Sig for the posttest was 0.498 > 0.05. These results show that the data normality test for the experimental and control groups using scientific-based numeracy literacy teaching materials had a normal distribution.

5. Homogeneity Test of Students' Higher-order Thinking Skills

Table 7. Homogeneity Test

		Levene Statistic	df1	df2	Sig.
Higher-order thinking	Based on Mean	1.044	1	62	.311
	Based on Median	1.009	1	62	.319
	Based on Median and with adjusted df	1.009	1	57.972	.319
	Based on trimmed mean	1.047	1	62	.310

Table 7 shows the significance value (Sig.) of the higher-order thinking skills is 0.311. Because of the Sig value. 0.311 > 0.05, it can be concluded that the data variance in students' higher-order thinking skills in the experimental and control groups is homogeneous.

6. Paired Samples T-Test of Students' Higher-order Thinking Skills

Table 8. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Experimental	32	14	52	32.34	8.896
Posttest Experimental	32	48	80	66.00	8.455
Pretest Control	32	4	46	19.31	10.104
Posttest Control	32	30	68	47.94	10.392
Valid N (listwise)	32				

Based on Table 8 and Figure 2, the data for the experimental group is 32 students, and the control group is 32 students. The average score for students' higher-order thinking skills for the experimental group posttest was 66.00, while for the control group posttest, it was 47.94.

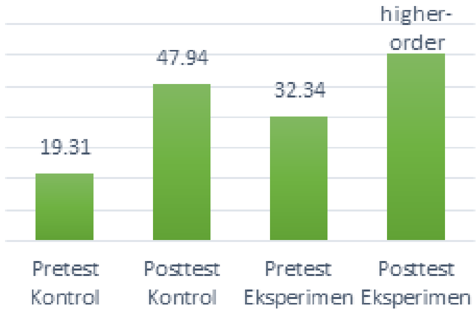

Figure 2. Difference in Students' Average Higher-order Thinking Skills

Thus, descriptive statistics show a difference in students' average higher-order thinking skills in the experimental group and the control group using scientific-based numeracy literacy teaching materials.

Table 9. Paired Samples t-test

		Mean	Std. Deviation	95% Confidence Interval of the Difference		Sig. (2-tailed)
				Lower	Upper	
Pair 1	Pre-Post Experiment	-33.66	9.16	-36.959	-30.354	.000
Pair 2	Pre-Post Control	-28.63	10.1	-32.267	-24.983	.000

Based on Table 9, the Sig value (2-tailed) is 0.000 < 0.05, and then, as is the basis for decision-making in the Paired sample t-test, it can be concluded that Ho is rejected and Ha is accepted. Thus, it can be concluded that there is a significant (real) difference between the average higher-order thinking skill scores of students in the experimental and control groups using scientific-based numeracy literacy teaching materials. The "Mean Difference" value is 6.938, showing the difference between the average posttest score for the experimental and control groups or 66.00-47.94 = 18.06, and the difference is -36.959 to -30.354 (95% Confidence Interval of the Difference Lower Upper).

The numeracy literacy teaching materials based on the scientific approach significantly increase students' motivation and higher-order thinking skills. Students taught with teaching materials based on the scientific approach showed higher motivation and developed better higher-order thinking skills than those taught without it. This indicates that the scientific approach is efficacious in improving learning outcomes and equipping students with the skills needed to face future challenges.

The discussion of this research focuses on the effect of numeracy literacy teaching materials based on the scientific approach on students' motivation and higher-order thinking skills. The results showed a significant increase in students' motivation and higher-order thinking skills after using the teaching materials. Some of the factors that support these results can be analyzed from the point of view of the scientific approach applied to numeracy literacy.

The scientific approach, which emphasizes exploration, experimentation, and critical analysis, seems important in increasing students' motivation to learn. When students are involved in an interactive and contextualized learning process, where they are encouraged to think critically and investigate, their intrinsic motivation to learn tends to increase (Grassinger et al., 2024; Lai et al., 2023;a powerful artificial intelligence chatbot, has great potential for active learning because of its ability to generate instant responses to academic inquiries and foster spontaneous interactions. Purpose: This exploratory study investigated the roles of intrinsic motivation and factors of the technology acceptance model that influence ChatGPT acceptance for active learning among undergraduates in Hong Kong. Method: Using a structural equation modeling approach, we examined the extended technology acceptance model in the context of higher education. Using self-report questionnaires, we obtained useful responses from 473 undergraduate students in Hong Kong in July 2023. The reliability and validity of the data were measured using confirmatory factor analysis, followed by path analysis to investigate the hypotheses in the proposed model. Results: We identified intrinsic motivation as the strongest motivator for ChatGPT use intention. Consistent with the prior literature on technology acceptance, perceived usefulness was found to be a strong predictor of behavioral intention. In contrast to extant research, the findings indicate no significant relationship between perceived ease of use and behavioral intention. Neither perceived usefulness nor perceived ease of use were significant mediators in the relationship between intrinsic motivation and behavioral intention. Conclusion: These findings highlight the significant effect of intrinsic motivation on ChatGPT acceptance in supporting students' active learning. They also provide inspiration for ChatGPT developers and educationalists regarding the importance of intrinsic and extrinsic motivation (perceived usefulness Rokhimawan et al., 2022; Otto & Thies, 2024). This exposure aligns with Branson et al. (2024)it is not well understood how participant experience of mock-crime activities might affect participants' desire to perform (well, who revealed that students feel more challenged and motivated because this approach invites them to find answers through observation and experimentation rather than passively receiving information. This aligns with motivation theory, which states that active engagement and self-discovery in learning can increase interest and drive to learn.

The scientific approach also supports the development of higher-order thinking skills, which include analysis, evaluation, and synthesis (Lee et al., 2024; Rusli et al., 2024). This exposure is in line with Yáñez de Aldecoa and Gómez-Trigueros (2022), who revealed that teaching materials designed with this approach encourage students to understand basic concepts and apply them in complex situations. For example, students are invited to solve problems that require critical thinking, connect numeracy concepts with real situations, and evaluate various possible solutions. This process deepens students' understanding of the material and strengthens their ability to think logically and systematically.

This improvement in higher-order thinking skills can also be attributed to the problem-based learning aspect often integrated with the scientific approach. When students face real problems that require creative solutions, they must apply various problem-solving strategies, strengthening their thinking skills (Loyens et al., 2023; Schaller et al., 2023). This exposure is in line with Syamsuddin et al. (2023), who revealed that numeracy literacy teaching materials based on the scientific approach serve as a tool to improve students' numeracy knowledge and as a means to develop their critical and creative thinking skills.

Applying the scientific approach in numeracy literacy teaching materials facilitates more meaningful learning and provides space for students to develop their metacognitive skills (Termaat, 2024). Metacognition, or the ability to think about how one thinks, becomes particularly important in learning processes that involve solving complex problems. When students face challenges requiring in-depth analysis and evaluation of various alternatives, they naturally begin to develop strategies to monitor and regulate their own thinking. This process allows students to become more aware of how they learn, which in turn can improve their ability to solve problems more effectively and efficiently (Triwahyuningtyas & Sesanti, 2023).

The motivation enhanced through this approach is also supported by the learning elements that are more contextual and relevant to students' real lives. Using real-life examples and practical applications in the teaching materials, students can see how the numeracy skills they learn can be applied in the real world. This makes learning more engaging and provides a sense of purpose and relevance, which is important in building long-term motivation. Students who see real value in what they are learning are more likely to stay motivated and engaged in the learning process, even when faced with complex challenges (Amin et al., 2022; Fischer & Brückner, 2024; Glüer-Pagin & Spectre, 2024).

Another aspect to note is how this scientific approach also supports differentiation of learning, allowing teaching materials to be tailored to different levels of student ability (Fatmawati et al., 2022; Subali et al., 2019). Thus, students who may have difficulty understanding certain concepts can be given additional support through a more visual or practical approach, while more advanced students can be given additional challenges that encourage them to think more deeply. This differentiation is important to ensure that every student, regardless of ability level, gets the opportunity to develop their higher-order thinking skills (Handayani et al., 2024; Kurniawan et al., 2024; Yanti & Anas Thohir, 2024; Walter, 2024).

During the research, using scientific-based numeracy literacy teaching materials significantly influenced students' learning activities. Learning becomes more productive, especially in sociocognitive interactions, for example in terms of asking questions, cooperation and group discussions between students increase, curiosity increases, the ability to explain concepts resulting from discussions increases, complete assignments and exercises well, and students become happier solving problem question or problem given (Firoozi et al., 2017; Mundelsee & Jurkowski, 2021; Iancu, 2014; Näykki et al., 2021). All of these positive influences directly impact increasing students' higher-order thinking skills and impact student learning outcomes (Iancu, 2014; Lu et al., 2021).

The success of this research is supported by research that has been carried out previously, including Amali et al. (2022), with the results of the benefits or advantages of assessing higher-order thinking skills being increased student learning motivation because the HOTS assessment connects classroom subject matter with real-world contexts so that learning is meaningful. Apart from that, HOTS assessment can improve student learning outcomes because it can train students to think creatively and critically, namely the ability to think that does not just remember (recall), restate, or refer without processing (recite), and assess thinking abilities high levels of students can increase the achievement of student learning outcomes so that students can compete nationally and internationally (Kurniawan et al., 2021; Nowlan et al., 2023).

Mohamed and Lebar (2017) and Saputri et al. (2019) state that assessments involving students' HOTS abilities: critical, logical, reflective, metacognitive, creative, non-routine, non-algorithmic problem-solving, analysis, evaluation, creating, involving concept formation, critical thinking, creativity, brainstorming, solving problems, mental representation, use of rules, reasoning, and logical thinking, and requires thinking to a higher level than simply restating facts. Thus, it can be concluded that applying scientific-based numeracy literacy teaching materials can increase students' motivation and higher-order thinking skills.

Overall, applying numeracy literacy textbooks based on the scientific approach to learning significantly positively impacts students' learning motivation and higher-order thinking skills. This approach emphasizes the importance of student-centered learning, where students are actively involved in the learning process and encouraged to think critically and creatively. Thus, the scientific approach not only improves academic achievement but also prepares students to become lifelong learners who can adapt to changes and face challenges in the era of globalization.

This study reveals that applying science-based numeracy literacy teaching materials significantly influences students' motivation and higher-order thinking skills. By using teaching materials designed to improve numeracy literacy, students become more motivated in learning and show a clear improvement in their critical and analytical thinking skills.

The results showed that students involved in learning activities with science-based teaching materials showed higher enthusiasm and more active involvement during the teaching and learning. They were more courageous in asking questions, exploring mathematical concepts in depth, and applying the knowledge they gained in real contexts. On the other hand, the improvement of students' higher-order thinking skills is reflected in their ability to solve complex problems, make generalizations, and evaluate the information provided. These skills are not only important in academic contexts but are also highly relevant to preparing students to face challenges in the real world.

Overall, the findings of this study indicate that integrating science-based numeracy literacy teaching materials not only increases students' motivation but also contributes to the development of higher-order thinking skills, which in turn can create a more critical and creative generation. Therefore, educators need to consider using teaching materials that align with scientific principles to improve the quality of learning and student achievement.

This research was conducted at Universitas Islam Negeri Syekh Ali Hasan Ahmad Addary Padangsidimpuan to examine the effect of using science-based numeracy literacy teaching materials on students' learning motivation and higher-order thinking skills. The results showed that this teaching material can positively influence increasing students' involvement in learning, encouraging intrinsic motivation, and developing their higher-order thinking skills. These results indicate that a science-based approach has great potential to support learning in higher education. However, the context in which the study was conducted, which was limited to Universitas Islam Negeri Syekh Ali Hasan Ahmad Addary Padangsidimpuan, is of particular concern in generalizing the findings. The characteristics of students, academic culture, and educational environment at the university may differ from other educational institutions, whether at the local, national, or international level. These differences may affect how the teaching materials are implemented, and the resulting impact, so caution is needed when applying these findings to different contexts. To understand the relevance and applicability of findings in different environments, it is important to consider factors such as differences in curriculum, faculty preparedness, and student background. This article needs to provide an in-depth analysis of how the research results can be adapted or applied to other populations, including different levels of education, institutions with diverse resources, or environments with unique academic cultures.

Thus, while the findings of this study make an important contribution to developing scientifically based teaching materials, further explanation of the limitations of its context and possible applications elsewhere is an important element. This will not only enrich the academic value of the research but also open up opportunities for further research exploring the effectiveness of these teaching materials in various educational settings.

This study examines the effect of using science-based numeracy literacy teaching materials on students' motivation and higher-order thinking skills. The findings showed a significant positive effect in the short term, where students who used scientific-based teaching materials showed increased learning motivation and critical, analytical, and creative thinking skills. These results indicate that teaching materials designed with a scientific approach can stimulate deeper student engagement and develop higher-order thinking skills. However, one of the main limitations of this study is the lack of longitudinal data. The study only focused on short-term effects without considering the sustainability of the impact of the teaching materials on students' motivation and higher-order thinking skills. The approach does not allow us to explore whether the observed improvements can be sustained over a longer period or whether other factors might influence the results over time.

In addition, this study has not explored in detail how other factors, such as teacher support, learning environment, and parental involvement, can influence the sustainability of the impact of science-based teaching materials. Support from these parties can play an important role in maintaining students' motivation and encouraging the application of higher-order thinking skills in diverse learning situations. Therefore, although the results of this study make a significant contribution to the development of science-based teaching materials, the existing limitations indicate the need for further research. Research designs that include longitudinal analyses and consider the influence of external factors are needed to provide a more holistic picture of the effectiveness of science-based numeracy literacy teaching materials in the short term and for long-term sustainability. As such, this study paves the way for further exploration of how innovations in teaching materials can sustainably improve the quality of learning.

CONCLUSION

Based on research findings, the average motivation score for the experimental class posttest was 66.09, while for the control group posttest, it was 64.19, while the average score for students' higher-order thinking skills for the experimental class posttest was 66.00, while for the control group posttest was 47.94. This is following the results of the Paired sample t-test calculation with a significance value of $0.000 < 0.005$ that there is a significant (real) difference between the average motivation score and higher-order thinking skills of students in the experimental and control groups using a scientific-based numeracy literacy teaching materials. It can be concluded that the scientific-based numeracy literacy teaching materials influence students' learning motivation and higher-order thinking skills.

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