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RESEARCH ARTICLE

Integrating Local Wisdom in Mathematics Concepts to Optimize Independent Learning

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ABSTRACT

The implementation of the Merdeka Curriculum as a recovery of the education system for students' lagging behind during the pandemic, encourages the need for students to be able to learn independently, especially in mathematics. The development of mathematics learning media that is effective and relevant to students, such as the integration of local wisdom in mathematical concepts, is one of the important facilities that can help students to learn, understand, and master mathematical concepts independently. student-centered learning models, such as context-based learning, problems, and projects, can be used in independent learning because they can increase interest and motivation in learning and encourage students to think logically and reason, where mathematical reasoning skills are an important element in supporting students' independent learning success. This study aims to analyze learning media based on PBL (Problem-Based Learning) model integrated with local wisdom of A'songko-songko Jangang traditional games on students' mathematical reasoning ability as a skill to support the success of independent learning. The research method used is pre-experimental with a one shot case study design. This research was conducted at SMAN 10 Gowa Sulawesi Selatan in the 2024/2025 school year with a total sample of 36 students. The sample was selected using random sampling technique. Data were analyzed using one-way ANOVA and simple linear regression. Statistical analysis was carried out using IBM SPSS 20. The results showed that PBL model-based learning media integrated with A'songko-songko Jangang local wisdom played a positive role in mathematical reasoning ability, so that it could optimize independent learning.

1. INTRODUCTION

The recovery of the education system after the COVID-19 pandemic has encouraged the government to develop a new curriculum that is more modern and based on students' lag during the pandemic, namely the Merdeka Curriculum, which is applied by educational units during the 2022/2023 learning year to the 2024/2025 learning year. According to Mulyasa (2023), in implementing the Merdeka Curriculum, there is a reduction in learning load and a reduction in learning hours, especially classroom learning hours, as well as a reduction in the syllabus or teaching subject matter which is considered to be burdensome for students. The Merdeka Curriculum emphasizes skill development and the development of students' personalities and creativity (Muliardi, 2023). However, the evolution of education still encourages an increase in the complexity of the syllabus of material that students need to learn and master. For example, in mathematics, every new school year, the syllabus and basic competency targets change and increase. The materials that were previously studied in grade 12 of high school have begun to be lowered and have been studied in grade 11 and even grade 10 of high school, which illustrates the flexibility of changes in the material syllabus in implementing the Merdeka Curriculum (Jojor and Sihotang, 2022). Not only subject matter, but mathematics exam questions have been oriented to the type of HOTS (Higher Order Thinking Skill) questions. This type of question

encourages students to be able to think broadly and deeply about a problem, which includes the ability to analyze, evaluate, and create (Widhiyani et al., 2019; Safitri et al., 2024). This means that the implementation of the Merdeka Curriculum contradicts the need for students to explore mathematical concepts, in order to be able to conquer HOTS questions, especially in preparing to enter the university level.

The contradiction between the implementation of modern education and the needs of students in achieving satisfactory academic results, opens up new skills that need to be mastered by students, namely the ability to learn independently. According to Herawati et al. (2023), independent learning is an important aspect of modern education, which emphasizes students' ability to manage their own learning experiences. In Harden (2009), it is explained that time for independent learning is not formally scheduled in the curriculum and appropriate learning resource materials and support for students are often not provided. The formal provision of facilities by schools to at least support students' independent learning activities is only textbooks. However, the main thing that makes learning as independent learning is the activity that is done by a student for himself, without assistance from the teacher. This independent learning is usually carried out by students after obtaining formal learning in the classroom, so students have a source of handbook material in the form of notebooks and textbooks that can be used to continue independent learning sessions. Not a few basic materials or concepts still have to be explored more deeply through electronic or internet information sources due to the limited coverage of the syllabus presented in textbooks and notebooks. The intensity of independent learning in Merdeka Curriculum usually increases before daily tests, midterm exams, final exams, school exams, or college entrance exams, with students trying to revise or master concepts and materials in a relatively short time, sometimes at the expense of attendance at other scheduled sessions (Sari, 2019; Nurhafsari and Subandar, 2018).

In the face of a modern curriculum system that encourages increased student self-learning needs should be balanced with the fulfillment of learning facilities and media to facilitate student learning, especially in understanding materials and concepts independently. Lusiana and Maryanti (2020) in their research focusing on online learning environments revealed significant difficulties faced by students when facilities and media do not support collaborative and interactive learning. Students reported challenges in absorbing the material presented during online classes, which was exacerbated by the lack of effective feedback mechanisms and engaging content. This situation underscores the need for well-designed learning media to facilitate understanding and encourage independent learning. To encourage students' learning independence, it is crucial to choose the right teaching materials and learning media. A study showed that teachers' freedom in choosing the right media can have a significant impact on students' understanding. However, if the available facilities are inadequate or the media used is ineffective, this can cause difficulties for students in learning independently (Mangesa and Andayani, 2015; Mana and Harti, 2023). In line with research by Hikmah (2019) and Kandia et al. (2023) which discuss the strategic role of learning media in optimizing student learning outcomes. The research noted that when the right media is not used, students will have difficulty understanding the material effectively. The research shows that different types of media (audio, visual, and audiovisual) are essential for improving understanding and engagement. Without access to effective learning media, students may find it difficult to learn independently.

The challenges students face in independent learning increase when dealing with mathematics. One of the fundamental aspects of education is understanding and mastering mathematical concepts. Mathematics is not just a subject, it is a language that allows everyone to express relationships between quantities and solve complex problems. A deep understanding of mathematical concepts is essential for building a solid foundation in mathematics, which is critical for academic and career success (Prastyani et al., 2019; Putri and Nasution, 2023; Liberna and Lestari, 2024). Many students already have enough difficulty in understanding mathematical concepts even when accompanied by a teacher or mentor. The difficulty increases when students have to understand mathematical concepts independently Amaliyah et al. (2021) in her research on students' mathematical problem-solving abilities within a self-directed learning framework, identified that many students struggle with independence in learning, often relying heavily on teacher explanations rather than actively seeking knowledge. This is reinforced by Lusiana and Maryanti (2020) who also identified significant difficulties that students experience when trying to understand mathematical concepts independently. Key challenges include poor material absorption due to inadequate digital media, hindering an effective learning experience. This underscores the need for

better resources and strategies to facilitate better understanding in self-directed learning. Similarly, Rahmawati et al. (2024) who support efforts to provide a learning atmosphere and facilities that support, motivate, and encourage students to develop positive mathematical dispositions, as well as emphasize the development of metacognitive skills and utilize effective learning technologies to facilitate independent learning in exploring mathematical concepts.

The integration of local wisdom into educational frameworks, particularly in mathematics, offers a unique approach to promote self-directed learning and mastery of mathematical concepts. Local wisdom refers to collective knowledge and practices that emerge from the cultural context and environment of a particular community. Local wisdom includes traditions, values and practices that have been passed down over many years. In an educational context, integrating local wisdom means using cultural elements to inform teaching practices and curriculum development. Research found that students who learned mathematics using local wisdom contexts demonstrated better understanding and engagement than those who received traditional learning. The integration of local wisdom into the learning process makes math more relevant and fun, thus overcoming students' difficulties in learning math (Sangadji and Umar, 2024). This is in line with research conducted by Kasi et al. (2024) and Kertiyani et al. (2023) that incorporating local wisdom in educational materials can improve students' comprehension skills and make learning more relevant to everyday life. Similarly, the results of research by Ladona et al. (2022) which showed that local wisdom-based materials significantly improved comprehension and problem solving skills in mathematics. By using a familiar context, students are more engaged and able to relate mathematical concepts to their daily experiences, thus improving their understanding and mastery of the subject.

The implementation of local wisdom-based self-directed learning is able to foster an environment where students can have a sense of ownership over their educational journey. Integrating local wisdom into self-directed learning significantly improves students' learning outcomes (Puspita et al., 2024). According to Harden (2009), self-directed learning, if planned appropriately can encourage a more active approach to learning. Students adopt a deep rather than superficial approach to learning and seek an understanding of the subject rather than simply reproducing what has been learned. Students are encouraged to think and not just remember the subject matter. According to Ali (2020), independent learning can provide space for students to gain extensive knowledge with independent control in exploring and developing potential, thus providing freedom for students to plan their learning activities.

However, an important element of self-directed learning is the skills required by students for success in self-directed learning. Moreover, Agusti et al. (2023) stated that one of the competency standards in learning mathematical concepts is reasoning ability. Students' ability to investigate, analyze, and organize material and design appropriate ways to draw conclusions or formulate new claims is an aspect of students' mathematical reasoning ability, will continue to have a good impact on students' mathematics learning (Arifin and Tsurayya, 2022). This is in line with the statement by Izzah et al. (2019) that mathematical materials and mathematical reasoning cannot be separated. In a study conducted by Meyer et al. (2008), identified the skills that students need to have to successfully engage in self-directed learning are cognitive skills, such as being able to establish formal rules to solve problems and logical reasoning. This is reinforced by Lisnawati and Mariani (2023) and Sitompul et al. (2024) that problem solving ability and mathematical reasoning have a significant influence on independent learning. Similarly, research by Rahmawati and Tsurayya (2023) found that students with high mathematical reasoning ability also have a high level of learning independence. In addition to problem solving and mathematical reasoning skills, student-centered learning models, such as context-, problem- and project-based learning, can be used in self-directed learning because they can increase interest and motivation in learning and knowledge (Rashid and Asghar, 2016).

As an effort to support students' skills to succeed in independent learning, the PBL (Problem-Based Learning) learning model is able to provide experience for students to find, explore, and solve given problems. Educators empower students to engage with mathematics independently by providing materials, media, and learning methods according to students' cultural backgrounds and are able to support students' problem solving and mathematical reasoning skills. For example, Parwati et al. (2018) who studied the effectiveness of PBL (Problem-Based Learning) learning model based on Balinese local wisdom. The results showed that this model significantly improved students' mathematical problem solving skills compared to traditional learning methods. In another study conducted by Sa'dijah et al.

(2024) which discusses the design of PBL mathematics learning model based on local wisdom of Malang. The results showed that there is potential for the integration of local wisdom in the PBL model in supporting students' critical and creative thinking skills. In line with Annafi and Agustina (2018) and Cahayu et al. (2024) who analyzed the effectiveness of the PBL model based on local wisdom in improving learning outcomes. The study found that students using the PBL model with local wisdom showed a significant increase in critical thinking skills compared to students in the control class. These findings are supported by Primayanti et al. (2019) which showed that there was an important influence of the PBL model containing local wisdom on the achievement of students' critical thinking skills. Critical thinking skills themselves can occur in the presence of good problem solving and reasoning skills from students. Then, research conducted by Kumullah et al. (2018) which states that students' analytical skills and understanding of science concepts when PBL models are applied, are higher than students taught by traditional models. This finding is also supported by Buana and Astawan (2020) who concluded that there is a significant effect of the Catur Pramana-based PBL model on students' critical thinking skills in mathematics.

Based on the description of the background and previous research, this study aims to analyze learning media based on the PBL (Problem-Based Learning) model integrated with the local wisdom of traditional A'songko-songko Jangang games on students' mathematical reasoning ability as a skill to support the success of independent learning. A'songko-songko Jangang local wisdom is used as an instrument for interpreting the mathematical concept of function definition, namely domain, codomain, and range. In addition, it can also be used to illustrate the concept of composition and inverse functions.

RESEARCH METHODS

The research conducted was experimental research. The type of experimental research used is pre-experimental. The experimental design in this study is "One Shot Case Study" (Sugiyono, 2016). In this research design, students are given intervention or treatment within a certain period of time, involving only one group of students, namely the experimental group. There are three stages in the research, namely the preparation stage, the implementation stage, and the final stage. This research was conducted at SMAN 10 Gowa Sulawesi Selatan in the 2024/2025 school year. The study population was all grade 11 SMAN 10 Gowa Sulawesi Selatan in the 2024/2025 school year as many as 425. "Sampling is done to determine the portion of the population to be the object of research, it must be appropriate to consider representation based on the population base, to obtain data and things that are needed (Indrawan and yaniawati, 2016). The sample in this study were grade 11 students as many as 36 students. The technique used to obtain the required sample uses random sampling. Data on students' mathematical reasoning ability was collected through an essay instrument consisting of 10 questions. The ten questions refer to indicators of logical thinking ability and problem solving ability as well as mathematics material for grade 11 high school. Indicators of logical thinking and problem solving skills, namely students can respond to explanations, identify the core of the problem, formulate the core of the problem, implement strategies, verify solutions, and provide conclusions.

This research was analyzed using descriptive analysis. The precondition tests conducted were data distribution normality test, heteroscedasticity test, and linearity test. The normality test of data distribution was conducted using the Kolmogorov-Smirnov test to ensure that the samples were normally distributed. The use of Kolmogorov-Smirnov test in this study is based on good power and sensitivity for small sample sizes, namely 36 data (Ghasemi and Zahediasl, 2012). The data that were tested for normality were mathematical problem solving ability data and mathematical reasoning ability data. Heteroscedasticity testing is done when the data has met the assumption of normality. This test is done to show the inequality obtained from hypothesis testing. The heteroscedasticity test uses the Glejser test because of its sensitivity to violations of the normality assumption. Next, hypothesis testing was carried out. The hypothesis in this study was tested using one-way ANOVA and simple linear regression analysis. In this study, the data were analyzed using SPSS Statistics 20.0 with a significance level of 5%.

RESULTS AND DISCUSSION

Data Description

Table 1. Statistics Descriptive

Variables	N	Min	Max	Mean	SD
Learning Media	36	62	89	79.17	6.300
Mathematical Reasoning Ability	36	77	91	83.47	3.629

Table 1, shows the data for learning media, which is taken based on students' opinions and satisfaction with the learning media provided, has an average value of 79.17 with a maximum value of 89 and a minimum of 62, while the score for mathematical reasoning ability has an average value of 83.47 with a maximum value of 91 and a minimum of 77. The standard deviation values of the two variables show the level of data distribution that does not vary too much.

Table 2. Distribution of Mathematical Reasoning Ability Scale

Category	Frequency	Percentage
High	7	19%
Medium	28	78%
Low	1	3%

Table 2 shows that 78% of students are in the medium category on mathematical reasoning ability. In addition, 19% of students were in the high category, and there were 3% students in the low category.

Assumption Test

Assumption tests are carried out before entering the hypothesis testing stage to determine whether or not the data is suitable for use in research. The first assumption test is the normality test which is carried out to check whether the remaining data is normally distributed. Through the Kolmogorov-Smirnov test, a significance value of 0.706 was obtained, where the p-value> 0.05. This means that the data used in this study is normally distributed. Then, a linearity test was conducted to determine whether or not there was a significant linear relationship between learning media as the independent variable and mathematical reasoning ability as the dependent variable. Based on the results of the linearity test, the significance value of deviation from linearity is 0.147, where the p-value>0.05. This value indicates a significant linear relationship between learning media and mathematical reasoning ability, so the linearity assumption is met. Selanjutnya, uji heteroskedastisitas dilakukan untuk memeriksa apakah residual data memiliki variansi yang berbeda atau tidak, yang mana dapat menyebabkan model regresi menjadi tidak akurat. Uji heteroskedastisitas dengan uji Glejser, menunjukkan nilai probabilitas 0.162, di mana $p - value > 0.05$. Hal ini menunjukkan bahwa tidak terdapat gejala heteroskedastisitas pada model regresi. Dengan demikian, data yang digunakan dalam penelitian ini telah lolos uji penerimaan dan dapat dilanjutkan ke tahap uji hipotesis. Furthermore, the heteroscedasticity test is conducted to check whether the residual data has different variances or not, which can cause the regression model to be inaccurate. The heteroscedasticity test with the Glejser test, shows a probability value of 0.162, where the p-value>0.05. This indicates that there are no symptoms of heteroscedasticity in the regression model. Thus, the data used in this study have passed the acceptance test and can proceed to the hypothesis testing stage.

Hypothesis Test

In Table 3, simple linear regression analysis shows that learning media has a significant influence on mathematical reasoning ability with a probability value of 0.005, where the p-value <0.05. The effect of learning media on mathematical reasoning ability is shown in the R value of 0.461. In addition, the R square value of 0.213 explains that learning media contributes positively to mathematical reasoning ability by 21.3% while the rest is explained by other variables that are not taken into account in this study. Thus, it is concluded that learning media has an effect on students' mathematical reasoning ability.

Table 2. Significance Test Results

ANOVA[a]

Model		*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
1	*Regression*	98.117	1	98.117	9.194	0.005[b]
	Residual	362.856	34	10.672		
	Total	460.972	35			

Table 3. Effective Contribution

Model Summary[b]

Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
1	0.461[a]	0.213	0.190	3.26684

Table 4. Regression Coefficient Results

Coefficients[a]

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	*(Constant)*	62.431	6.961		8.969	0.000
	Learning Media	0.266	0.088	0.461	3.032	0.005

Based on table 5, the probability value of the learning media variable is 0.005, where the p-value <0.05, then the learning media variable has a significant effect on mathematical reasoning ability. If the learning media variable is valued, then a constant value can be obtained on the math reasoning ability variable of 62.431. Furthermore, the regression coefficient value of the learning media variable is 0.266, where the p-value <0.05. Thus, the regression equation in this study is as follows.

Mathematical Reasoning Ability = 62.431 + (0.266 × learning media)

The equation explains that every addition of one number on the learning media, there is an increase of 0.266 in mathematical reasoning ability. The results of this research hypothesis test show that the learning media used in the experimental group plays a positive and significant role in improving

mathematical reasoning skills in 11th grade high school students, so that this research hypothesis is accepted.

Discussion

This study aims to analyze learning media based on PBL (Problem-Based Learning) model integrated with local wisdom of A'songko-songko Jangang traditional games on students' mathematical reasoning ability as a skill to support the success of independent learning. The results of the analysis showed that the learning media used in the experimental group proved to play a role and significant to improve mathematical reasoning ability in 11th grade students of SMAN 10 Gowa Sulawesi Selatan with R = 0.461. This means that the more qualified and relevant learning media, the higher the mathematical reasoning ability given to 11th grade high school students, so that it has good potential for the success of independent learning. And vice versa. Thus, the hypothesis of the study shows the result that the hypothesis is accepted.

Based on the results of the analysis that has been presented, it is known that the level of mathematical reasoning ability of grade 11 high school students is in the medium category, meaning that grade 11 high school students have a fairly high motivation to learn independently and are able to understand mathematical concepts well without the assistance of a teacher. This shows that after students get learning media that is relevant to everyday life, students' abilities become better in responding to explanations or mathematical problems of the narrative type, identifying and formulating problems in the narrative, executing appropriate mathematical solution strategies, being able to verify solutions by providing a few explanatory sentences to the solutions given, and being able to provide conclusions in accordance with the core questions in the problem. This student's mathematical reasoning ability is better because in the high category there are more than the mathematical reasoning ability in the low category.

Learning media based on the PBL (Problem-Based Learning) model integrated with local wisdom of traditional bentegan games supports students to achieve and develop good mathematical reasoning skills. One way to overcome the weak ability in mathematical reasoning and solving mathematical problems is to choose an appropriate learning model, which emphasizes problem solving activities while encouraging students to reason (Sánchez-Martín et al., 2017; Anggoro et al., 2023). Learning using problem-solving strategies has the potential to develop logical thinking skills and creative student thinking (Yusnaeni et al., 2017; Samani et al., 2019). The existence of learning media based on the PBL model provides training to students with real-life problems as a medium for students to learn critical thinking, problem-solving skills, and reasoning skills and gain knowledge (Mutakinati et al., 2018; Samani et al., 2019; Effendi and Hendriyani, 2020; Hartati et al., 2023; Setiawan et al., 2023; Nurhasanah et al., 2024). Tatar et al. (2016) also found that context-, problem-, and project-based learning methods can increase students' curiosity. This finding is supported by the research of Kumullah et al. (2018), stating that critical thinking skills and understanding of scientific concepts are higher in students who use the PBL model than those taught with the traditional model. In addition, learning media innovations integrated with local wisdom support the student learning process because students become more active in finding, exploring, and solving problems given while remaining relevant to everyday life (Buana et al., 2020; Kusumaningrum & Masruro, 2022; Komalasari et al., 2023). The integration of local wisdom in learning is also able to encourage students' interest in focusing and learning mathematical concepts that are considered complicated. This is because the values of local wisdom are inherent in the environment around students and are closely related to real life, so a learning model that can captivate student interest during the learning process becomes the correct learning model (Trust et al., 2016; Suryanti et al., 2020; Ramdiah et al., 2020; Dewi & Ramadan, 2021; Supiatman et al., 2023; Hulu et al., 2024). Local wisdom can make it easier for students to understand learning materials because it is around them (Trust and Whalen, 2020; Suryanti et al., 2020; Dewi & Ramadan, 2021; Hanifah et al., 2022; Supiatman et al., 2023).

According to Bahar and June-Maker (2015), Gultom et al. (2022), and Afifah and Fatmawati (2024), math problem solving trains students to always give reasons for their work. In line with Putri et al. (2019) which states that a person can reach a conclusion if they have the right reasons. This has implications for the development of students' logical thinking and reasoning skills to be able to understand mathematical concepts independently and capture the essence of narrative-type questions. Mathematical reasoning skills, along with good problem solving skills, are determined by students' prior

knowledge. Students' prior knowledge in mathematical reasoning has different effects on their ability to solve problems. Students with better prior knowledge tend to get better mathematical reasoning skills as well (Parwati et al., 2018; Xhomara, 2020; Alreshidi, 2023; Kania et al., 2023). The implication is that the success of students' independent learning is not only supported by effective learning media, but also the mathematics teaching received from teachers during class. Thus, the role of learning media on students' mathematical reasoning ability, as a support for successful independent learning, is 21.3% due to other contributing factors, one of which is the teaching of mathematics in the classroom. In addition, the success of independent learning can also be influenced by student factors in regulating their thoughts, behaviors, and feelings in navigating learning experiences (Saeid and Eslaminejad, 2017; Arifin and Herman, 2018; Tekkol and Demirel, 2018; Ramli et al., 2018; Robinson and Persky, 2020).

CONCLUSSION

This study examines the learning media based on the PBL (Problem-Based Learning) model integrated with the local wisdom of traditional A'songko-songko Jangang games on students' mathematical reasoning ability as a skill to support the success of independent learning. The results of the study found that PBL model-based learning media integrated with A'songko-songko Jangang local wisdom plays a positive role in mathematical reasoning ability. This means that learning media with good quality and increasingly relevant to real life and daily habits can optimize independent learning through the development of mathematical reasoning skills better, and vice versa.

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