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The effectiveness of miniature media in improving Junior High School students' learning outcomes in specific gravity

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ABSTRACT

This study aims to analyze the effectiveness of using miniature kelong media in improving the learning outcomes of junior high school students on the subject of mass density. Miniature kelong is a local wisdom-based learning medium that represents the structure of traditional fishing gear in the coastal area of Bintan Regency. The study used a mixed methods approach with a quasi-experimental design involving two classes: an experimental class taught using miniature kelong media and a control class taught conventionally. Data were collected through pre-tests and post-tests, then analyzed using t-tests and normalized gain. The results showed that the average increase in learning outcomes (normalized gain) in the experimental class was much higher than in the control class. The t-test showed a significant difference between the two groups. These findings prove that the kelong miniature media is effective in improving student learning outcomes because it is able to present the abstract concept of density in a concrete, contextual, and meaningful way through a local cultural approach. The implications of this study support the integration of local wisdom in science learning to improve the quality of education in coastal areas.

INTRODUCTION

Learning media is needed to address the abstract nature of the concept of mass density, which is often difficult for junior high school students to understand. The concept of the relationship between mass, volume, and density of objects cannot be sufficiently understood through verbal explanations and mathematical formulas alone, but requires visual representations and concrete experiences. Concrete and manipulable media help students visualize physical phenomena that are not directly visible (Ragohang et al., 2024). In science education, media serve as a bridge between theoretical concepts and real phenomena experienced by students. The use of media that is relevant to the students' environment also increases learning engagement and facilitates the process of conceptual understanding. Therefore, concrete media such as miniature kelongs are an effective means of helping students understand the concept of mass more meaningfully.

Constructivism theory supports the use of concrete media in learning because it emphasizes that knowledge is constructed through direct experience and active interaction with the environment (Yasin & Masykuri, 2025). Students do not simply receive information from the teacher, but construct their own understanding through the process of observing, trying, and reflecting on the phenomena being studied. In the context of density learning, concrete media allow students to observe floating and sinking events and relate them to scientific concepts. This process strengthens conceptual understanding because students directly experience the relationship between theory and reality. Manipulative media also encourages students' cognitive and psychomotor engagement during learning. Thus, the use of concrete media is in line with the principles of meaningful learning emphasized in constructivism theory.

Local wisdom-based learning strengthens the context, motivation, and relevance of learning materials for students. When scientific concepts are linked to the culture and environment in which students live, learning becomes closer to their daily experiences. This approach helps students understand that science is inseparable from the social and cultural realities of society (Fathoni, 2024).

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The integration of local wisdom also increases learning motivation because students feel that learning has meaning and value for their lives. In addition, local culture-based learning plays a role in fostering a sense of belonging and appreciation for regional cultural identity. Therefore, the use of media based on local wisdom, such as miniature kelongs, makes science learning more contextual, relevant, and meaningful.

The learning of density concepts at the junior high school level is often perceived as abstract and difficult for students to understand because the learning process tends to emphasize procedural mastery of formulas rather than conceptual understanding. Theoretically, the concept of mass density requires students to be able to relate the mass, volume, and density of an object in a real context in order for meaningful learning to occur. When learning does not provide opportunities for students to relate these concepts to direct experiences, students have difficulty understanding physical phenomena related to everyday events, such as objects floating or sinking. This condition is in line with the findings of Ichsan (2025), who states that the lack of concrete and contextual learning media causes students to only memorize formulas without understanding the physical meaning behind the concept of mass density.

This phenomenon is even more apparent in schools located in coastal areas, such as Teluk Sebong District, Bintan Regency, which have limited laboratory facilities and science practicum tools. Theoretically, science learning requires active student involvement through observation and simple experiments so that scientific concepts can be constructed independently. However, limited resources mean that learning is still verbalistic, with teachers dominating the explanation and students playing a passive role as listeners (Diasti, 2021). As a result, students' conceptual understanding does not develop optimally, as reflected in the learning outcomes for density material over the last three years, which were in the range of 65–67, still below the minimum passing standard set by the school.

To overcome this problem, learning media is needed that can connect scientific concepts with concrete experiences that are close to students' lives. One approach that is considered relevant is learning media based on local wisdom, which not only aids cognitive understanding but also develops cultural awareness. Miniature kelongs, which are replicas of traditional fishermen's buildings built on the sea for fishing and daily activities, are one type of media that has the potential to be used in science learning. The kelong miniature serves as a physical representation of the phenomena of density and buoyancy, allowing students to directly observe how the kelong structure can remain afloat on the water's surface. This medium not only explains physics concepts but also connects learning with the maritime cultural identity inherent in the lives of the coastal communities of Bintan (Irawan & Muhartati, 2019).

Various previous studies have shown that the use of local culture-based learning media has a positive impact on the learning process and outcomes of students. Fariha & Andrijati (2024) reported that the integration of local wisdom in learning can increase student activity and make learning materials feel closer to their daily lives. Yusuf & Rahmat (2020) found that local culture-based learning creates meaningful learning experiences because the concepts studied are directly related to the social environment in which students grow up. Similar findings were also reported by Lestari (2025), who showed that local culture-based learning media contribute significantly to improving students' understanding of science concepts compared to conventional learning. In addition, Hadi et al. (2025) emphasized that the integration of local culture in learning not only improves cognitive understanding but also strengthens students' motivation and positive attitudes toward the learning process.

However, these studies are generally still general in nature and have not specifically examined the use of specific concrete media that represent local culture in physics learning. In particular, research examining the effectiveness of using kelong miniatures as a medium for teaching mass type at the junior high school level is still very limited. Most previous studies have emphasized affective and motivational aspects, while the influence of locally-based media on improving conceptual learning outcomes in mass type material has not been studied in depth. This condition indicates a research gap that needs to be addressed.

The novelty of this study lies in the use of kelong miniatures as concrete learning media based on local maritime culture in teaching the concept of mass density at the junior high school level. Unlike previous studies that utilized local wisdom in a general or symbolic manner, this study presents kelong miniatures as physical representations that allow students to interact directly with the phenomena of floating and sinking.

This approach integrates physics concepts, students' empirical experiences, and coastal cultural values into a contextual and meaningful learning process. Based on these gaps and novelty, this study aims to examine the effect of using miniature kelong as a teaching aid on junior high school students' learning outcomes in density, while also assessing the contextual and cultural relevance of its application in a coastal educational environment.

Theoretically, this study is expected to enrich the study of local wisdom-based science learning by presenting empirical evidence on abstract physics material. Practically, the results of this study are expected to serve as a reference for teachers in developing contextual learning media that are in line with the cultural characteristics and environment of students.

RESEARCH METHODS

This study used a mixed methods approach with a quasi-experimental design involving two groups, namely the experimental class and the control class. This approach was used to obtain a quantitative picture of the effectiveness of learning media through student learning outcomes and a qualitative picture through the implementation of learning in the classroom. The research subjects were seventh-grade students at SMP Negeri 10 Bintan as the experimental class and SMP Negeri 8 Bintan as the control class, each consisting of 23 students. The subjects were selected using purposive sampling, considering the similarity of school characteristics in terms of geography, culture, and the curriculum implemented (Etikan & Bala, 2017).

The research instruments included a learning outcome test consisting of 20 multiple-choice questions that had been validated and had high reliability, as well as observation and documentation sheets to obtain qualitative data on the learning process. Data collection was carried out through pre-tests and post-tests, with the treatment being the use of local culture-based Kelong miniature media in the experimental class, while the control class used conventional learning. Data analysis was conducted quantitatively using normality and homogeneity tests as prerequisites for analysis, followed by an independent t-test to determine the difference in learning outcomes between the two groups. In addition, normalized gain (N-Gain) was used to measure the level of effectiveness of the improvement in student learning outcomes. Qualitative data were analyzed descriptively to support the interpretation of quantitative results.

RESULTS AND DISCUSSION

This study aims to reveal the effect of applying miniature kelong media on student learning motivation in teaching the concept of mass density in eighth grade junior high school. As a preliminary step, students' motivation was measured prior to the intervention using a questionnaire covering nine aspects of learning motivation, namely learning autonomy, self-control in learning, interest and enthusiasm, understanding of the material, active participation, self-efficacy, clear learning objectives, learning independence, and perseverance and effort.

Student motivation before using miniature kelong media in learning about density

Student motivation to learn is one of the determining factors for success in the learning process, as it is closely related to student engagement, perseverance, and interest in the material being taught. In the context of science learning, especially density, motivation is crucial given that the concept is abstract and often considered difficult by students. A high level of motivation can encourage students to ask more questions, engage in exploration, and connect concepts with real-life experiences. Conversely, low motivation has the potential to hinder understanding and reduce student participation in learning activities. Therefore, understanding the state of student motivation both before and after learning interventions is an important step in evaluating the effectiveness of an approach or learning medium, including the use of kelong miniatures that integrate local values into science learning.

Student motivation questionnaire data was collected using a Likert scale-based instrument consisting of a number of statements related to intrinsic and extrinsic motivation aspects, including interest, curiosity, perception of material benefits, and involvement during learning. The questionnaire was completed by all student respondents before and after the application of miniature kelong media in mass learning, in order to capture changes in their perceptions and motivation levels. The questionnaire results were then analyzed quantitatively to obtain average motivation scores for each aspect, which were then used as a basis for interpreting initial motivation levels and their improvement after the intervention. This data became one of the main sources for revealing the extent to which miniature kelong media in mass type learning based on local culture was able to influence student learning motivation in understanding abstract science concepts.

Table 1 Student Motivation Questionnaire Data before using miniature kelong media in mass learning Types

No	Question Item Number	Number of Students	Number of Correct Answer Scores	Number of Incorrect Answer Scores	Correct Answer Percentage (%)	Percentage of incorrect answers (%)
1	1	46	**25**	21	54,35	45,65
2	2	46	**30**	16	65,22	34,78
3	3	46	**21**	25	45,65	54,35
4	4	46	**14**	32	30,43	69,57
5	5	46	**20**	26	43,48	56,52
6	6	46	**27**	19	58,70	41,30
7	7	46	**29**	17	63,04	36,96
8	8	46	**10**	36	21,74	78,26
9	9	46	**22**	24	47,83	52,17
10	10	46	**24**	22	52,17	47,83
11	11	46	**30**	16	65,22	34,78
12	12	46	**23**	23	50,00	50,00
13	13	46	**22**	24	47,83	52,17
14	14	46	**30**	16	65,22	34,78
15	15	46	**29**	17	63,04	36,96
16	16	46	**17**	29	36,96	63,04
17	17	46	**23**	23	50,00	50,00
18	18	46	**30**	16	65,22	34,78
19	19	46	**27**	19	58,70	41,30
20	20	46	**18**	28	39,13	60,87

Based on Table 1, which contains data from the student motivation questionnaire before using the miniature kelong media in learning about mass density, it can be seen that the initial level of student motivation was relatively low. Of the 20 statements answered by 46 students, the average percentage of "correct" answers (reflecting positive motivation) was only around 50.33%. In fact, several items showed a percentage of correct answers below 40%, such as item 8 (21.74%), item 4 (30.43%), and item 16 (36.96%). This indicates that most students did not have a strong interest, confidence, or positive perception of science learning before the media intervention was carried out.

Furthermore, there was a significant gap between the items with the highest and lowest motivation. Items 2, 11, 14, and 18 had the highest percentage of correct answers, namely 65.22%, which was still classified as moderate and did not reach the high category. Meanwhile, the majority of other items were in the range of 30–50%, indicating an attitude that tended to be hesitant or even negative towards the learning process and content. This pattern illustrates that students may have had

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difficulty understanding the material, felt bored, or did not see the relevance of science material in their daily lives before the use of innovative learning media.

Before the learning intervention using miniature kelong media was carried out, students' learning motivation was measured through a questionnaire developed based on specific motivation indicators in the context of science learning. The instrument covered nine main aspects of motivation, namely learning autonomy, self-control in learning, interest and enthusiasm, understanding of material, active participation, self-efficacy, clear learning objectives, learning independence, and perseverance and effort. The data obtained from this questionnaire provided an overview of the initial state of student motivation, which was an important basis for assessing the effect of learning media on increasing motivation during the learning process. The analysis describes each aspect of motivation based on the percentage of student responses, in order to identify strengths and areas that need improvement before applying miniature kelong media in learning about mass types.

Table 2 Grouping according to aspects of motivation from student motivation questionnaire data before using miniature kelong media in learning about mass types based on data

No	Motivation Aspect	Indicator	Nomor Butir Soal	Persentase Jawaban (%)	Persentase Jawaban (%)	Persentase Jawaban (%)	Rata - rata Persentase Jawaban (%)
1	Learning Autonomy	Students choose to study without coercion	1 and 5	**54,35**	**43,48**		48,91
2	Self-Control in Learning	Believing that efforts will bring results	10 and 15	**52,17**	**63,04**		57,61
3	Interest and Enthusiasm	Enthusiastic about participating in science lessons	2 and 7	**65,22**	**63,04**		64,13
4	Material Understanding	Easier to understand science concepts with tools	3 and 19	**45,65**	**58,70**		52,17
5	Active Participation	Engage in class discussions and activities	4, 8 and 20	**30,43**	**21,74**	**39,13**	30,43
6	Self-Efficacy	Confident in solving problems	6 and 18	**58,70**	**65,22**		61,96
7	Learning Objectives Are Clear	Have a clear learning goal	9 and 14	**47,83**	**65,22**		56,52
8	Learning Independence	Independent learning outside of school hours	12, 13 and 16	**50,00**	**47,83**	**36,96**	44,93
9	Perseverance and Effort	It's not easy to give up when it's hard	11 and 17	**65,22**	**50,00**		57,61

Based on data from a student motivation survey conducted prior to the use of miniature kelong media in density lessons, it appears that student motivation in general is still low to moderate in almost all aspects. Autonomy and independence in learning show percentages below 50%, indicating that most students still learn due to external encouragement and are not yet accustomed to independent learning. Self-control, self-efficacy, learning objectives, and perseverance were in the moderate range, indicating that students' confidence and efforts were not yet fully strong and sustainable. Interest and enthusiasm are the highest aspects, but there is still a group of students who are less interested in science learning. Material comprehension and active participation are low, indicating that students have difficulty understanding abstract concepts and are less involved in the learning process. Overall, these conditions indicate the need for learning innovations with concrete and contextual media to increase student motivation, comprehension, and involvement.

The Effect of Miniature Kelong Media on Learning Motivation and Learning Outcomes

To understand the extent to which learning motivation and initial learning outcomes (pretest) contribute to final learning outcomes, this study uses multiple linear regression analysis. This approach allows researchers to test the simultaneous influence of several predictor variables, in this case two dimensions of learning motivation (Motivation_1 and Motivation_2) and pretest scores on the dependent variable, namely final learning outcomes (Posttest). Thus, in addition to determining the contribution of each variable individually, this analysis also provides an overview of the overall strength of the model in explaining the variation in student learning outcomes, which can be used as a basis for designing more effective interventions or learning strategies. The following are the SPSS results of the influence of learning motivation and learning outcomes using Kelong miniature media.

Table 3 ANOVA Multiple Regression

	ANOVA[a]					
	Model	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	64,811	3	21,604	40,339	<,001[b]
	Residual	22,493	42	,536		
	Total	87,304	45			

a. Dependent Variabel: Posttest
b. Predictors: (Constant, Motivation_1, Motivation_2, Pretest

Table 3 ANOVA shows that the multiple linear regression model is highly significant in explaining the variation in Posttest scores (final learning outcomes), with an F value of 40.339 and significance (p) < 0.001. This means that the combination of predictor variables—namely Motivation_2, Motivation_1, and Pretest—together contribute significantly to explaining the differences in student learning outcomes. The Sum of Squares Regression value of 64.811 out of a total of 87.304 shows that the model is able to explain most of the variation in the Posttest, while the Residual Sum of Squares of 22.493 reflects the variation that cannot be explained by the model. Thus, although not all individual variables are significant (based on the coefficient table), overall this regression model has strong predictive power and is suitable for use in understanding the factors that influence final learning outcomes.

Table 4 *Coefficients,* Multiple regression

	Coefficients[a]					
	Model	**Unstandardized Coefficients**		**Standardized Coefficients**		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constants)	-,177	,812		-,219	,828
	Motivation_1	-,054	,075	-,089	-,718	,477
	Prestest	,214	,165	,163	1,299	,201
	Motivation_2	,450	,044	,831	10,334	<,001

a. Dependent Variable: Posttest

Based on Table 4 Coefficients, multiple linear regression analysis shows that only the variable Motivation_2 has a significant effect on Posttest (final learning outcome), with a regression coefficient value of 0.450 and significance (p) < 0.001. This means that every one-unit increase in *Motivation_2* will increase the *Posttest* score by 0.450 units, assuming other variables remain constant. The standardized coefficient (*Beta*) of 0.831 confirms that *Motivation_2* is the most dominant predictor in this model. Conversely, *Motivation_1* and *Pretest* did not show a significant effect on *Posttest* (*p* > 0.05), despite the positive direction of the relationship for *Pretest* and the negative direction for *Motivation_1*. Overall, *Motivation_2* is the only variable that significantly predicts improved

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learning outcomes in this model. Thus, the null hypothesis is rejected and the alternative hypothesis is accepted. These results confirm that in learning using miniature kelong media, intrinsic motivation is the main determinant of student science learning success.

Table 5 Comparison of Pre-test and Post-test Scores between the Control Class and the Experimental Class

Groups	Number of Students	Average Pretest	Average Postest	Average Increase	Normalized gain
Control Class	23	4, 93	6.52	1, 59	0,31
Experimental Classes	23	4, 78	8,30	3, 52	0,68

Before the learning treatment was given, both research groups had relatively equal initial abilities. This can be seen from the pre-test average scores, which were not much different, namely 4.93 in the control class and 4.78 in the experimental class. This equality indicates that the classes had comparable academic readiness, so that differences in results after learning could be directly attributed to the learning media used, rather than the students' initial factors. Equality in initial abilities is an important requirement in educational experimental research (Sugiyono, 2021).

The findings of this study are in line with previous literature that emphasizes the importance of initial ability equivalence as a prerequisite for validity in educational experimental research. The similarity in the average pre-test scores between the control class and the experimental class shows that there was no significant difference in the students' initial abilities before the treatment was given, so that the learning effects that appeared at the final stage can be attributed more convincingly to the intervention that was applied. These results are consistent with Sugiyono's (Sugiyono, 2021) view that initial equality between groups is a key requirement for differences in learning outcomes to truly reflect the influence of the treatment, rather than initial subject bias. Similar findings were also reported by Sudiana et al. (2025), who emphasized that relatively equal pre-tests strengthen internal validity in quasi-experimental designs in education.

Furthermore, the results of this study are also in line with the findings of previous studies that used quasi-experimental designs in science learning. Research by Adawiyah et al. (2025) shows that groups with comparable initial abilities provide a strong basis for objectively interpreting differences in learning outcomes after treatment. These findings also support the results of research by Fahmiyah et al. (2025), which states that the equivalence of students' initial abilities allows researchers to focus their analysis on the effectiveness of the learning strategies or media used. Thus, the findings in this study reinforce the consistency of empirical evidence that controlling initial abilities is a crucial methodological practice in educational experimental research.

After the learning process took place, there was an increase in learning outcomes in both groups, but the increase was much more significant in the experimental class. The experimental class experienced an increase of 3.52 points, compared to the control class, which only increased by 1.59 points. The greater increase in the experimental class indicates that the use of miniature kelong media contributed significantly to the understanding of the concept of mass density.

Furthermore, the normalized gain ($\langle g \rangle$) results show that the experimental class achieved a value of 0.68 (medium-high category), while the control class only achieved 0.31 (lower-medium category). According to Buntu & Zainal (2025), an N-Gain value ≥ 0.6 indicates that learning has a significant conceptual strengthening effect, not just an increase in scores as a result of practicing questions.

Thus, quantitative data show that miniature kelong media not only improve final scores but also deepen students' conceptual understanding of the relationship between mass, volume, and buoyancy in real life.

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Discussion

The significant improvement in learning outcomes in the experimental class shows that miniature kelongs are effective in facilitating density learning. This effectiveness is related to the nature of miniature kelongs as concrete manipulative media, which allow students to interact directly with physical models during the learning process. This is in line with the theory of meaningful learning proposed by Ausubel (in Muamanah, 2020), which states that learning will be meaningful if new information is linked to students' existing experiences and cognitive structures. When students observe miniature kelongs that can float on the surface, they make connections between real objects and the concepts of density and buoyancy.

The kelong miniature media allows students to directly observe the application of the concept of mass density in the phenomena of floating and sinking, connect physics concepts ($\rho = m/V$) with the daily experiences of coastal communities, and develop scientific process skills, such as measuring, comparing, analyzing, and drawing conclusions based on the observations made during learning activities. Furthermore, because kelong is part of Bintan's maritime cultural identity, the use of this media has a positive impact on students' affectivity and learning motivation. According to Amaliyah et al. (2023), the integration of local wisdom creates learning that is relevant to the students' social environment, thereby increasing their sense of belonging and interest in the material.

These findings are in line with the research by Setyansah & Putra (2024), which shows that locally-based media increases learning outcomes by up to 25% compared to conventional learning. This reinforcement shows that the success of the kelong miniature media is not a coincidence, but consistent with previous research results. Furthermore, Pratiwi & Setiawan (2025) explain that local culture-based learning strengthens the relationship between scientific concepts and cultural values that exist in society. This means that the use of kelong miniatures not only helps students cognitively but also serves as a means of preserving coastal culture in the context of education.

These findings are in line with the views of Fauzi & Rahmatih (2025), who state that local culture-based learning can increase student motivation, engagement, and understanding because the learning material is related to their real lives. In addition, these findings reinforce the results of Primayana et al. (2019), who concluded that the use of culture-based contextual media can significantly improve science learning outcomes compared to conventional learning models. Thus, kelong miniature media not only functions as a visual aid but also as a means of internalizing scientific concepts and strengthening local cultural identity. This study has several limitations that need to be considered when interpreting the findings. First, the scope of the study was limited to two schools with a relatively small sample size, so generalizing the results to other schools with different characteristics should be done with caution. Second, the study focused only on density material, so the effectiveness of the kelong miniature media on other physics concepts cannot be ascertained.

In addition, the relatively short duration of the treatment did not fully capture the long-term impact of using local wisdom-based media on students' conceptual understanding and scientific attitudes. Based on these limitations, further research is recommended to involve a larger sample size and a more diverse school context so that the findings obtained have stronger generalizability.

Further research could also examine the application of miniature kelong media in other physics materials or different science subjects, as well as add more in-depth measurements of affective aspects and 21st-century skills. In addition, studies with long-term designs need to be conducted to determine the sustainability of the impact of local wisdom-based learning on students' conceptual understanding, learning motivation, and preservation of cultural values.

CONCLUSION

The use of miniature kelong media has been proven effective in improving junior high school students' learning outcomes in density material. This is demonstrated by higher learning outcomes in the experimental class compared to the control class, with a normalized gain of $\langle g \rangle = 0.68$ in the experimental class (medium-high category) and $\langle g \rangle = 0.31$ in the control class (lower-medium

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category). This achievement indicates that miniature kelong media can strengthen students' conceptual understanding, not just improve test scores. The effectiveness of this media is due to its ability to concretize abstract concepts into learning experiences that can be observed and manipulated directly by students. In addition, the integration of local wisdom in learning media makes learning activities more contextual, meaningful, and relevant to the cultural experiences of coastal students. For science teachers, especially in coastal areas, integrating locally-based media into science learning processes is an innovative strategy to improve the quality of education. Local governments and schools also need to support the production and utilization of contextual learning media that draws on the cultural potential of the region, so that education not only builds academic competence but also preserves local cultural values as part of the character of students.

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