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Culturally integrated interactive worksheets based on maritime Malay context to enhance mathematical literacy in grade VII differentiated learning

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Abstract

The low level of students' mathematical literacy, particularly in linking mathematical concepts to daily life, remains a challenge in education. This study develops an interactive Student Worksheet that incorporates Malay maritime culture to enhance seventh-grade students' mathematical literacy through differentiated learning. Cultural elements such as the traditional game porok and the fish trap *bubu* are included, since both represent proportional concepts relevant in mathematics. Differentiation is based on diagnostic tests of students' literacy levels and applied to process and content aspects, adjusted to their readiness. The research follows the ADDIE development model through analysis, design, development, implementation, and evaluation phases. Practicality testing involved one mathematics teacher and 30 students from Class VII.E at SMP Negeri 17 Bintan, while effectiveness testing used the same participants. Data were collected using interviews, validation and practicality questionnaires, and literacy tests adapted from the 2022 PISA framework, focusing on reasoning and problem-solving. The findings show the worksheets is highly valid (88.14%) and practical, with positive responses from the teacher (93%) and students (88.40%). An N-Gain score of 0.75 (high category) confirms effectiveness. These results indicate that the developed worksheets successfully improve students' mathematical literacy through differentiated learning and the integration of Malay maritime culture.

Keywords: interactive worksheets, malay maritime culture, mathematical literacy, differentiated learning, independent curriculum

I. Introduction

Education plays an important role in improving the quality of human resources and serves as a foundation for facing the challenges of the times (Wibawa & Agustina, 2019). Law number 20 of 2003 on the national education system emphasizes a conscious and planned effort to create an active learning environment that enables students to develop their full potential. Education aims not only to produce intelligent and skilled individuals but also to shape character and personality that benefit society, the nation, and the state.

One of the key indicators of global One of the key indicators of global education quality is the Program for International Student Assessment

(PISA), which measures the abilities of 15-year-old students in reading, mathematics, and science literacy (OECD, 2023). Unfortunately, Indonesia's performance in PISA remains relatively low, particularly in mathematical literacy. In the 2018 PISA cycle, Indonesia scored 379 in mathematics, ranking 72nd out of 79 countries, and in 2022, the score declined to 366, despite a slight improvement in ranking to 70th out of 81 countries. These results highlight the urgent need for substantial improvements in mathematics education. Similar conditions are reflected in the Minimum Competency Assessment (AKM), where the mathematical literacy rate among Indonesian junior high school students is categorized as moderate. At SMP Negeri 17 Bintan, achievement is slightly higher, but students continue to struggle in translating real-life problems into mathematical representations, interpreting information, and applying problem-solving strategies.

Several studies have addressed these challenges by proposing contextual approaches. (Oktaviani, 2023) emphasized the importance of connecting mathematics with real-world applications to foster functional literacy, while (Wulandari et al., 2023) highlighted that low performance often stems from students' limited experience with contextualized problems. Research by (Wahyuningtyas et al., 2020) shows that local culture can be integrated into mathematics learning to make it more meaningful. However, most studies remain focused on conceptual contextualization without embedding differentiated (Ayuningsih et al., 2024). Moreover, few studies have explored the integration of maritime Malay culture, rich with proportional concepts in fishing practices, traditional games, and social structures as a meaningful context for mathematics learning.

One promising solution is the use of interactive student worksheets. Prior studies (Nissa et al., 2021) report that interactive worksheets enhance engagement, provide scaffolding, and support personalized learning. Nevertheless, there is still a lack of worksheet designed specifically to integrate maritime Malay culture while simultaneously supporting differentiated learning.

In response, this study aims to develop an interactive worksheet that incorporates Malay maritime culture and supports differentiated instruction for seventh-grade students. The novelty of this research lies in combining cultural contextualization with differentiated learning in an interactive format, expected to improve mathematical literacy by making learning both meaningful and adaptive. This research is anticipated to contribute to mathematics education by providing valid, practical, and effective learning resources that address the diverse needs of students while preserving cultural relevance.

II. Research Method

This study is a research and development (R&D) project aimed at producing a learning product in the form of an interactive student worksheets that incorporate Malay maritime culture. The product is developed to enhance students' mathematical literacy within the context of differentiated learning. The development process follows the ADDIE model, which consists of five stages Analyze, Design, Development, Implementation, and Evaluation (Branch, 2009).

In the Analyze phase, needs, materials, and student characteristics were examined to identify problems and determine learning objectives. The Design phase involved drafting the worksheets' structure, storyboard, and instruments for validation, practicality, and effectiveness. During the Develop phase, the interactive worksheet was created, integrated with Maritime Malay cultural elements, and validated by experts in content, media, and language. The Implement phase consisted of classroom trials with Grade VII students at SMP Negeri 17 Bintan to test practicality and effectiveness. Finally, in the Evaluate phase, data from validation, practicality, and effectiveness tests were analyzed to assess the quality of the product and identify areas for improvement.

The study was conducted at SMP Negeri 17 Bintan. The research subjects consisted of two groups: for the practicality test and the effectiveness test, both carried out at the same school. The practicality test involved a mathematics subject teacher and 30 seventh-grade students from class VII.E to evaluate the ease of use, usefulness, attractiveness, and user satisfaction toward the developed worksheets through a questionnaire. The effectiveness test also involved the same 30 students from class VII.E, using pretest and post-test assessments to evaluate their mathematical literacy improvement.

The instruments used in this study included a validation questionnaire, a practicality questionnaire, and pretest–posttest items. The validation questionnaire was assessed by three validators consisting of a mathematics education expert, a media design expert, and a language expert. It was designed to obtain qualitative and quantitative data regarding the product's feasibility in terms of content, media, and language aspects. The practicality questionnaire, administered to one mathematics teacher and 30 students, evaluated the ease of use, clarity of instructions, and relevance of the worksheets to students' learning needs. Both questionnaires were self-developed but adapted from existing instruments in previous studies, and their validity was ensured through expert judgment and revision cycles.

Meanwhile, the pretest and posttest consisted of mathematical literacy problems based on the 2022 PISA framework, covering the three processes of formulating, applying, and interpreting mathematical problems in real-life contexts. For example, one item required students to determine proportional relationships in the design of a traditional fish trap (*bubu*), while another asked them to interpret ratios from distances in the *porok* game. These instruments were used to measure the improvement of students' mathematical literacy after using the worksheets. The data were analyzed according to their types. To begin with, the qualitative data derived from validation and practicality questionnaire scores were analyzed using Likert scale scoring techniques and converted into percentages using the following formula:

$$\text{Score Percentage (\%)} = \frac{Total\ Score}{Maximum\ Score} \times 100$$

The interpretation of the levels of validity and practicality was based on the criteria proposed by (Tegeh, 2014) as follows:

Table 1. Scoring validation product

Score	Criteria
5	Strongly Agree (SS)
4	Agree (S)
3	Doubt (RG)
2	Disagree (TS)
1	Strongly Disagree (STS)

The product is considered valid and practical if it achieves a score of ≥ 75%. Subsequently, quantitative data from the pretest and posttest results based on the 2022 PISA framework, focusing on mathematical reasoning and problem-solving processes, were analyzed through several stages. The analysis included empirical validity testing to examine whether each item accurately measured the intended construct, reliability testing using Cronbach's Alpha to assess internal consistency, item difficulty analysis to determine the relative difficulty level of each test item, and an item discrimination index to evaluate the ability of each item to distinguish between high- and low-performing students.

First, a validity test of the test items was conducted using the Product-Moment correlation to determine the extent to which each item measured what it was intended to measure. An item was considered valid if the calculated correlation coefficient (r-count) was greater than or equal to the critical value from the r-table.

Next, the reliability of the instrument was tested using Cronbach's Alpha formula to assess the internal consistency of the items. An instrument was considered reliable if the R-value

was ≥ 0.7.

The item difficulty level was analyzed using the ratio between the average score of the upper group and the maximum possible score, using the following formula:

$$\text{Item Difficulty Level (IDL)} = \frac{\bar{X}_i}{\bar{X}_i maks}$$

Information:

$\bar{X}_i$ = The average score obtained by students on question item i

$\bar{X}_i maks$ = Maximum possible score achieved on the item question i-th

Criteria difficulties grains is as following.

Table 2. Level of Difficulty Item

Difficulty Level Score Interval	Criteria
0.00-0.30	Difficult
0.31-0.70	Currently
0.71-1.00	Easy

(Source: Hairun, 2020)

The discrimination index of each item was calculated by finding the difference between the average scores of the upper and lower groups, divided by the maximum possible score.

$$DP = \frac{\bar{x}_{KA} - \bar{x}_{KB}}{Max\ Score}$$

Information:

$\bar{x}_{KA}$ = Average score of the upper group

$\bar{x}_{KB}$ = Average score of the lower group

Criteria discrimination index is used as follows.

Table 3 Criteria is the discrimination index

Score Interval	Criteria
0.40-1.00	Tall
0.30-0.39	Enough
0.20-0.29	Low
0.00-0.19	Very Low

(Source: Fatimah & Alfath, 2019)

As the final step, the effectiveness of the worksheets was analyzed by calculating the Normalized Gain (N-Gain), using the following formula:

$$N - Gain = \frac{S_{Post} - S_{Pre}}{S_{maks} - S_{Pre}}$$

Information:

S_{Post} *Posttest* Score

S_{Pre} *Pretest* Score

S_{maks} Maximum Score

The criteria for interpreting the effectiveness level based on the N-Gain score follow the classification proposed Hake (1999) , as follows:

Table 4 Criteria N-Gain calculation

Gain Index Value	Criteria
0.00-0.30	Low
0.31-0.70	Currently
0.71-1.00	Tall

(Hake, 1999)

The product is considered effective if the N-Gain value falls within the medium or high category based on classical (group-level) criteria.

III. Results and Discussion

The research findings are organized according to the stages of the ADDIE development model, which consists of five phases: Analyze, Design, Development, Implementation, and Evaluation (Branch, 2009) .

The initial stage of development is the Analyze phase, which includes three main focuses: needs analysis, material analysis, and student characteristics analysis.

First, a needs analysis was conducted through interviews with teachers and students, as well as classroom observations at SMP Negeri 17 Bintan. The results indicated that learning was still dominated by lecture-based methods, while the use of student worksheets remained limited and procedural. The existing worksheets were generally not contextual and did not promote a deep understanding of mathematical concepts. (Septian et al., 2019). This condition highlights the need for instructional materials that are engaging, contextual, and aligned with students' characteristics (Tomlinson, 2001) .

Second, the material analysis was conducted by examining the alignment between

the mathematics content being taught and students' learning needs. Based on the 2024 Education Report of SMP Negeri 17 Bintan, it was found that the number domain, including fractions and ratios, posed a significant challenge, with students achieving a mathematical literacy score of only 60.94%. Therefore, the topic of ratios and proportions was selected due to its high relevance to everyday life and strong potential to be developed through contextual learning (Muslimah, 2020) .

Third, the analysis of student characteristics was conducted through a diagnostic test to map students' readiness levels in mathematical literacy. The results revealed three categories of readiness: high, medium, and low, with a distribution of 17 students in the high category, 10 in the medium, and 3 in the low. These findings emphasize the importance of implementing differentiated instruction to ensure that the learning process can accommodate the diverse levels of student readiness (Auliyah et al., 2024) .

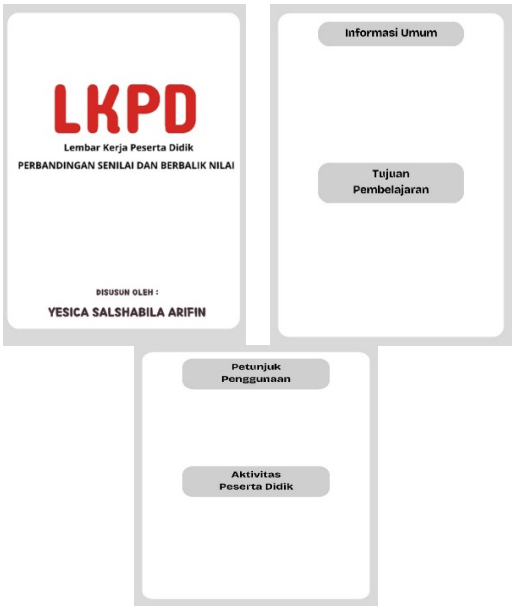
The Design stage also involved the addition of interactive elements such as navigation buttons, animations, and contextual video links. These media components were developed using interactive platforms to create a more engaging and dynamic learning experience (Costadena & Suniasih, 2022)

The worksheet activities were designed in accordance with the 2022 PISA framework, focusing on mathematical reasoning and problem-solving process, which include formulating, applying, and interpreting mathematical problems (OECD, 2022). Each activity was structured progressively, starting from local cultural contexts, followed by concept exploration, and ending with reflection. The worksheet was designed in three different versions based on students' readiness levels (high, medium, and low), ensuring that the learning process is accessible to all students according to their abilities. This strategy aligns with the principles of differentiated instruction. (Tomlinson, 2001)

The worksheets' content is integrated with Malay maritime culture, both visually and narratively, to enhance the relevance of the material and motivate student learning (Kurniawan & Syafriani, 2021). Each activity is accompanied by self-reflection tasks to foster students' metacognitive awareness and enhance their critical thinking skills.

With a design that considers content structure, differentiation, cultural context, and interactivity, this stage serves as a crucial foundation for developing Student Worksheets that are adaptive, meaningful, and aligned with the Independent Curriculum. During the Design stage, the researchers developed a storyboard as a draft outlining the worksheets' specifications. The storyboard is divided into three sections, as follows:

a. Front of Worksheets

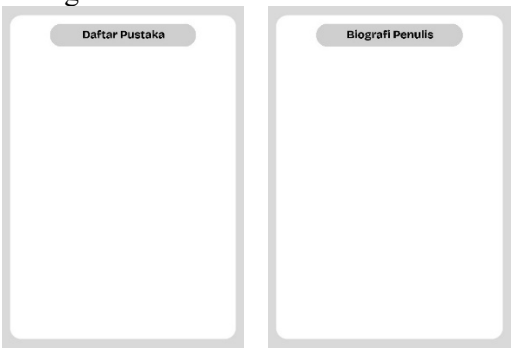


Picture 1. Front of worksheet

b. Worksheet Content Section

Picture 2. Contents of worksheet

c. Closing Section of Worksheet



Picture 3. Contents of worksheet

At the design stage, the researchers not only focused on developing the content of the interactive worksheets, but also on constructing evaluation instruments to be used in the processes of validation, practicality testing, and effectiveness testing. The development of these instruments was carried out concurrently to ensure that all aspects of the product could be systematically and objectively assessed. his aligns with the findings of Hidayat & Muhamad, (2021), who emphasize the importance of integrating evaluation tools during the product design phase in order to obtain a comprehensive assessment of its quality.

The validation instrument was developed to evaluate the content quality, visual design, and language appropriateness of the interactive worksheets. The construction of this instrument referred to the guidelines issued by the Ministry of Education and Culture (Kemendikbud, 2016) and was adapted to align with the principles of local culture-based development. The validation process involved three experts: a subject matter expert, a media expert, and a language expert. This finding is in line with the study conducted by Najamuddin et al., (2022) which emphasizes the importance of expert involvement in ensuring the quality of educational instruments and products. The validation results showed very high scores: 92.50% for the subject matter validation instrument, 92.50% for the media validation instrument, and 90.00% for the language validation instrument. These scores indicate that the instruments used to assess the quality of the worksheets met the required standards in terms of content feasibility, visual design, and effective language use. This supports the assertion by Rochmadyan & Zayyadi (2025) hat validation scores exceeding 90% that validation scores above 90% reflect the quality of high-performing educational instruments.

The practicality instrument was developed in two version, one for teachers and one for students. This instrument was designed to assess the ease of use, clarity of instructions, and visual appeal of the worksheet from the users' perspective. This is supported by (Maimunah, 2019), who emphasized that end-user perception is essential to ensure successful implementation. Initial validation indicated that the instrument was feasible for use, requiring only minor revisions. After refinement, the practicality instrument yielded an average score of 88.80% for the teacher response instrument and 88.40% for the student response instrument. These findings are consistent with the study by Abdillah et al., (2023) which showed that practical learning products significantly contribute to increased student engagement during the learning process. Therefore, it is necessary to have instruments capable of assessing the practicality of such learning products.

An effectiveness instrument was also developed to evaluate the impact of the worksheets on student learning outcomes through pretest and posttest assessments. The instrument was designed based on mathematical literacy indicators from the OECD's Program for International Student Assessment the OECD's PISA (2023), which include the abilities to formulate problems, apply mathematical procedures, and interpret results in real-life contexts. Initial validation yielded a score of 85.56%, indicating the instrument was valid. Empirical testing showed that all items possessed adequate content and empirical validity, high reliability, and appropriate difficulty and discrimination levels. These findings align with Hairun (2020) who noted that highly reliable instruments are essential for accurately measuring product effectiveness.

Overall, the three instruments, the validation instrument, the practicality instrument, and the effectiveness instrument developed during the design phase demonstrated a high level of feasibility and could measure the quality of the developed product. These instruments serve as key indicators to ensure the product's readiness before entering the implementation stage. This is in line with the statement by Husna et al., (2025), who emphasized that comprehensive validation of instructional instruments is essential to ensure the quality and reliability of educational products.

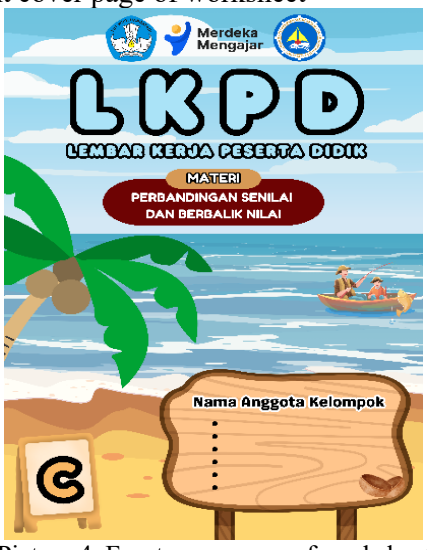
The development stage is a crucial phase in the instructional design process, aimed at translating the conceptual framework into a tangible product in the form of Student Worksheets. In this study, the worksheet was developed not only with attention to content and visual presentation, but also through the integration of maritime Malay local cultural context, principles of differentiated learning, and mathematical literacy indicators as outlined in the PISA framework. The selected material, proportional and inverse comparisons, aligns with the Merdeka Curriculum for 7 Grades and findings from previous studies that highlight the importance of this topic as a foundation for understanding more advanced mathematical concepts such as percentages and scale (Putra et al., 2025).

The development of three worksheet versions based on students' learning readiness levels (low, medium, and high) was designed to accommodate learner diversity. This approach follows the recommendations of Tomlinson (2001) and is supported by Ayuningsih et al., (2024) who emphasized that differentiated learning provides equitable and adaptive access to instruction.

In terms of media, the interactive worksheet was developed using the Canva platform and enhanced with QR codes that link to various supplementary materials, such as contextual videos, digital quizzes, and illustrations related to local culture. The use of digital media has been proven effective in enhancing students' motivation and engagement in learning (Costadena & Suniasih, 2022) . In this study, the integration of Maritime Malay cultural elements such as the traditional fish trap (*bubu*), the *porok* game, and fishermen's daily activities is not merely symbolic but is represented through mathematical concepts.

For example, the structure of the *bubu* reflects direct proportion, the *porok* game can be modeled using concepts of distance and speed, while the distribution of fish catches among fishermen illustrates fractions and inverse proportion. By embedding these cultural contexts into worksheet tasks, mathematics learning becomes more meaningful as students can connect abstract concepts with situations familiar to their daily lives. This pedagogical approach demonstrates that the integration of local culture not only provides cultural relevance but also enriches mathematical understanding, thereby strengthening the effectiveness of differentiated learning. This approach represents the implementation of ethnomathematics, which is considered effective in enhancing conceptual understanding while also reinforcing local cultural values (Ramadanita & Yuniati, 2023). The worksheet content was developed in a structured manner, consisting of the following sections:

a. Front cover page of worksheet



Picture 4. Front cover page of worksheet

b. General information

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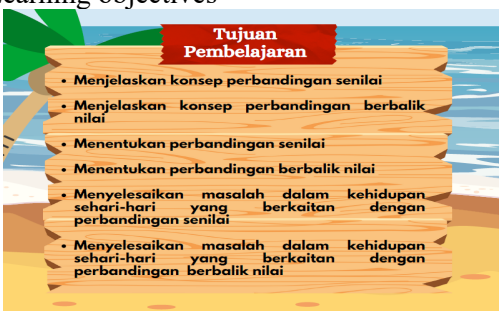
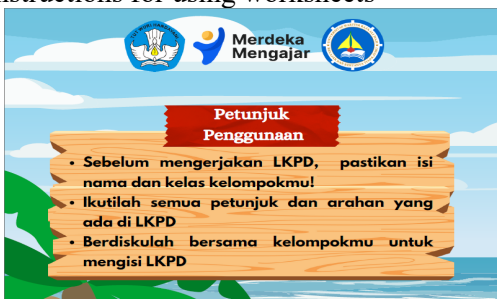
Picture 5. General information

c. Learning objectives



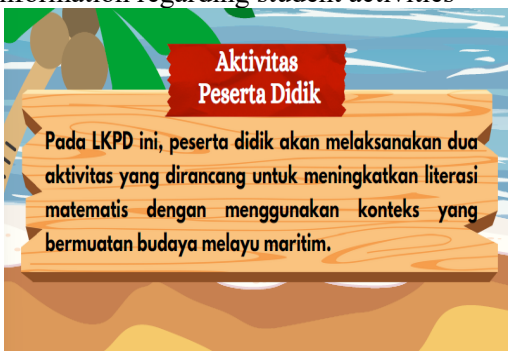
Picture 6. Learning objectives

d. Instructions for using worksheets



Picture 7. Instructions for using WORKSHEET

e. Information regarding student activities



Picture 8. Information regarding student activities

f. Student activities

Picture 9. Student activities

g. Quiz

Picture 10. Quiz

h. Bibliography

Picture 11. Bibliography

i. Author Biodata

Picture 12. Author's biodata

Next, validation was conducted as a crucial step to assess the product's feasibility prior to implementation. The validation process involved three main aspects: content, media, and language. Validation by material experts emphasized content relevance to learning outcomes, content accuracy, and integration with differentiated learning principles and local cultural contexts. The results showed that the worksheet possessed very high validity with an average score of 83.81%. Several suggestions, such as improving cultural illustrations and activity instructions, were addressed through revisions, in accordance with the principle of continuous improvement in instructional material development (Branch, 2009) .

From the media perspective, validation was carried out by university lecturers and mathematics teachers, focusing on visual presentation, layout, typography, illustrations, and coherence of presentation. The results yielded an average score of 83.08%, with the highest rating for visual coherence (90%). The incorporation of QR codes to access visual materials and additional content was seen as an innovative strategy supporting interactive visual learning (Riniwanti et al., 2024) . Feedback from initial validators, such as refining the activity instructions and bibliography formatting, was addressed to ensure clarity and accuracy.

Language validation involved linguists from secondary schools and higher education institutions. This process focused on clarity of instructions, diction, sentence structure, and spelling accuracy. The average validation score was 91.25%, indicating that the language used was communicative and appropriate for the students' cognitive development level (Dhera et al., 2024). Minor revisions were made to correct spelling errors and enhance the clarity of instructions, following the principles of educational communication (Putri et al., 2024) .

Overall, validation across these three aspects confirms that the developed interactive worksheet meets the eligibility standards for content, design, and language. The product is deemed suitable for use in contextual mathematics instruction rooted in maritime Malay culture, employing a differentiated learning approach. This aligns with the OECD (2019), recommendations, which emphasize that effective instructional materials should be contextual, communicative, and foster student engagement and reflection. Hence, the development and validation phases demonstrate that the worksheet is of high quality and ready for implementation and effectiveness testing.

The implementation phase served as an initial trial to assess the feasibility and effectiveness of the interactive worksheet incorporating maritime Malay culture in Grade VII mathematics instruction. As suggested by Sugiyono (2016), this stage is vital for evaluating product application in real classroom settings. The implementation took place over five sessions

involving 30 students at SMP Negeri 17 Bintan, who had previously been grouped into three categories (high, medium, and low learning readiness of Mathematical Literacy) based on diagnostic test results. This grouping enabled optimal application of differentiated instruction.

Following the implementation of the interactive worksheet integrating Malay maritime culture, posttest results indicated a significant improvement in students' mathematical literacy skills. Students not only demonstrated greater accuracy in formulating real-world situations into mathematical representations, but also began to apply mathematical concepts and procedures more effectively to solve contextual problems. Out of the 30 students involved in the effectiveness testing, 25 successfully completed the posttest and met the three indicators of mathematical literacy: formulating mathematical problems from real-life contexts, appropriately applying mathematical concepts and procedures, and interpreting and reflecting on the results of their calculations in accordance with the original context. Nevertheless, several errors were still observed during problem-solving, particularly in the form of computational mistakes. Additionally, five students continued to struggle with the third indicator, especially in connecting their calculated results to the appropriate meaning within the context of the problem.

Overall, these findings demonstrate a positive development in students' mathematical literacy skills after using the developed interactive worksheet. The use of the worksheet during the learning process enhanced student engagement and active participation, while also fostering adaptive learning experiences. In the third and fourth sessions, the contextual approach emphasizing local culture successfully improved students' independence and self-confidence. This supports the findings of (Misnawati et al., 2024), which stated that culturally based instruction can strengthen students' identity while deepening their understanding of mathematical concepts.

Evaluation of the product's practicality revealed highly positive results. Teachers gave an average score of 93%, while students gave 88.40%. The aspects of usability, attractiveness, and language clarity were rated highly, indicating that the worksheet was easy to understand, engaging, and suitable for the allocated instructional time. These findings are supported who stressed that interactive, culture-based learning materials significantly enhance student engagement in the classroom. In terms of effectiveness, there was a notable improvement from the average pretest score of 26.17 to a posttest average of 84.17, with an N-Gain of 0.75, classified as high (Hake, 1999). The detailed results are presented in Table 4.

Table 4 Results of Effectiveness Assessment of the worksheets

Learning Outcomes		Average N-Gain Score	Improvement Category
Average Pretest	Average Posttest		
26.167	84.167	0.752	High

This improvement reflects the worksheet's success in developing the three mathematical literacy indicators outlined by the OECD, (2023) formulating, applying, and interpreting mathematical concepts in real-world contexts.

The evaluation stage represents the final phase that determines the product's overall readiness for wider use. This evaluation was based on the previously collected data on validity, practicality, and effectiveness. The validity scores were high across content (84.76%), media (83.08%), and language (98.57%), indicating that the worksheet met the required standards in educational content, visual presentation, and effective language use Cahyono (2020). The practicality results were also strong, with an average of 93% from teachers and 88.40% from students, demonstrating that the worksheet was user-friendly and aligned with the classroom environment. These findings are consistent with those of, who emphasized that interactive and contextual instructional materials enhance classroom management effectiveness.

The effectiveness of the worksheet was further supported by an N-Gain score of 0.751,

categorized as high, indicating a significant improvement in students' mathematical literacy. This is reinforced by Mahpudin & Yuliati (2019), who asserted that culturally based learning improves mathematical understanding and enables students to relate it to real-life contexts. After the intervention, students showed significant improvements in the three mathematical literacy indicators formulating, applying, and interpreting where previously they only copied information, they were now able to construct problem-solving strategies and reflect meaningfully on the results.

Following the implementation of the interactive worksheet integrating Maritime Malay culture, the posttest results showed a significant improvement in students' mathematical literacy skills. Students not only demonstrated greater accuracy in formulating real-world situations into mathematical representations but also applied mathematical concepts and procedures more effectively to solve contextual (OECD, 2023). Of the 30 students involved, 25 successfully completed the posttest and achieved the three indicators of mathematical literacy: formulating mathematical problems from real-life contexts, applying appropriate concepts and procedures, and interpreting results in accordance with the original context (OECD, 2023). Nevertheless, several errors were still observed during problem-solving, particularly computational mistakes. Moreover, five students continued to struggle with the third indicator, especially in connecting their answers to the appropriate meaning within the context of the problem. This difficulty may have stemmed from limited familiarity with the cultural contexts embedded in the tasks or from aspects of the instructional design that require further refinement (Branch, 2009).

Overall, these findings demonstrate that the developed worksheet was effective in enhancing mathematical literacy while simultaneously strengthening student engagement and participation. The integration of cultural elements such as the bubu and porok provided authentic contexts that improved students' motivation and independence (Kurniawan & Syafriani, 2021). This supports previous studies indicating that culture-based instruction not only improves conceptual understanding but also reinforces cultural identity (Misnawati et al., 2024).

However, it is important to acknowledge the limitations of this study. The intervention was conducted in a single school with students living in coastal areas, which may limit the generalizability of the findings (Sugiyono, 2016). Questions remain as to whether this approach would be equally effective in non-coastal schools or when applied to different cultural contexts. In addition, the worksheet was limited to the topic of ratio and proportion and considered differentiation only in terms of students' readiness based on cognitive aspects of mathematical literacy (Tomlinson, 2001). Future research could broaden the scope by testing culturally integrated differentiated worksheets across various mathematical topics, grade levels, and student characteristics, as well as exploring cultural contexts beyond the Maritime Malay setting (Ayuningsih et al., 2024).

IV. Conclusion

The development of an interactive worksheet incorporating Maritime Malay culture to enhance mathematical literacy in differentiated learning for Grade VII junior high school students was carried out using the ADDIE model, which consists of the stages: Analysis, Design, Development, Implementation, and Evaluation. The results indicate that the developed worksheet is valid, with average validation scores of 83.81% from material experts, 83.08% from media experts, and 98.57% from language experts.

The product was also practical, receiving an average score of 93.00% from teachers and 88.40% from students. Furthermore, the worksheet proved to be effective in improving students' mathematical literacy, as shown by an increase in the average score from 26.167 (pretest) to 84.167 (posttest), with an N-Gain value of 0.75, categorized as high. Therefore, the interactive worksheet inco rporating Maritime

Malay culture is proven to be valid, practical, and effective for use in differentiated mathematics learning to improve the mathematical literacy of seventh-grade students.

However, this study has several limitations. First, the development of the interactive worksheet only focused on the topic of Ratio and Proportion for Grade VII in accordance with the Independent Curriculum. Second, the research was limited to the application of an interactive worksheet within the context of Maritime Malay culture, which frames the differentiated learning approach. Third, differentiated instruction in this study only accommodated students' characteristics based on learning readiness, specifically cognitive aspects reflected in mathematical literacy. Future research could extend the application of culturally integrated differentiated worksheets to other mathematical topics, different grade levels, and more diverse student characteristics, as well as explore other cultural contexts.

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