



Analysis of Students' Problem-Solving Ability through Coastal Culture–Based Realistic Mathematics Learning

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Abstract: This study investigates students' mathematical problem-solving ability through Coastal Culture–Based Realistic Mathematics Education (RME). Problem-solving is a critical 21st-century competency and a central goal of mathematics education; however, conventional instruction often fails to connect mathematical concepts with students' real-life contexts. The objective of this study is to analyze the effect of RME on students' mathematical problem-solving abilities after they receive realistic learning based on coastal potential. A quasi-experimental design with a pretest–posttest control group was employed, involving 120 eighth-grade students from three junior high schools in West Seram Regency. The experimental group received coastal potential–based RME instruction, while the control group experienced conventional learning. Data were analyzed using descriptive statistics, normality and homogeneity tests, independent t-tests, and ANOVA. The results revealed a significant difference in improvement between the experimental and control groups ($p < 0.05$), with the experimental group achieving a moderate and effective N-gain (67.8%), compared to the ineffective gain in the control group (20.8%). The findings conclude that coastal culture–based RME is more effective in enhancing students' problem-solving abilities than conventional methods. This study contributes to mathematics education by integrating local cultural context into RME, providing an innovative framework for contextualized learning in secondary education.

Keywords: mathematics learning based on coastal potential; problem-solving; realistic mathematics education;

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INTRODUCTION

Problem-solving is widely recognized as one of the essential competencies of the 21st century and has become a major focus in educational systems worldwide. Among school subjects, mathematics is considered the discipline most closely related to the development of problem-solving skills. One of the primary objectives of mathematics education is to enhance students' capacity to address and solve a variety of complex problems. Research conducted in China indicates that positive teacher–student relationships have a direct and beneficial impact on students' mathematical problem-solving abilities. Furthermore, students' levels of anxiety also influence their performance in solving mathematical problems (Zhou et al., 2020). In the contemporary era, societies are expected to develop educated individuals who are capable of adapting to a world characterized by rapid change and continuous development (Stehle & Peters-Burton, 2019).

Additionally, employers and higher education institutions increasingly expect school graduates to possess strong knowledge and competencies, particularly in mathematics (Di Martino et al., 2023). Consequently, several countries, including Turkey, England, Scotland, and Singapore, have introduced comprehensive educational reforms by prioritizing the development of problem-solving skills within their national mathematics curricula (Naroth & Luneta, 2015; Tan-Şişman & Karsantik, 2021). Similarly, Ireland implemented a major reform of its secondary school mathematics curriculum beginning in 2010 through a phased approach (Lubienski, 2021). While the previous curriculum mainly emphasized mathematical structures, abstraction, and rigorous conceptual understanding, the revised curriculum placed greater emphasis on problem-solving by incorporating more real-life contexts and applications, enabling students to connect mathematical concepts with their everyday experiences (Stacey, 2005).

Problem-solving is an individual's ability to identify, analyze, and resolve challenges using appropriate strategies and actions. This process enables individuals to generate effective solutions to the problems they encounter (Amalina & Vidákovich, 2023). It is considered one of the most advanced cognitive processes individuals use to manage and respond to various situations in life. The process of solving problems requires engaging in multiple cognitive activities that involve applying knowledge, reasoning, and specific skills, including both routine and non-routine thinking processes. Research involving high school students in Sweden found that students often follow recurring cycles during problem-solving, including understanding the problem, recalling mathematical knowledge, carrying out mathematical procedures, and managing their problem-solving (Szabo & Andrews, 2018). Problem-solving strategies are broad, adaptable, and systematic approaches used to address and resolve problems effectively (Fülöp, 2021). For this reason, problem-solving should be considered a

fundamental component of educational curricula, as its integration into learning can increase student motivation, create enjoyable learning experiences, stimulate interest, and encourage creativity (Wu et al., 2019).

Furthermore, problem-solving is an essential ability that children should acquire and continuously develop. This skill is particularly important for gifted students, who require opportunities to strengthen their problem-solving abilities while also maintaining psychological well-being and emotional stability (Fitzsimons & Fhloinn, 2023). In mathematics education, problem-solving plays a central role because it enables students to apply their existing knowledge and skills to unfamiliar or non-routine problems, thereby enriching their learning experiences (Schoenfeld, 2016). In addition, mathematics anxiety has been identified as an indirect factor influencing students' performance in mathematical problem-solving (Özcan & Gümüş, 2019). Previous research also indicated that teacher–student relationships contribute to students' mathematical problem-solving abilities through mediating variables such as self-efficacy and mathematics anxiety. However, self-efficacy demonstrated only a limited influence on mathematics anxiety, and the direct relationship between anxiety and problem-solving performance was not fully clarified, except in relation to teacher involvement in subject learning (Kaskens et al., 2020). Mathematical problem-solving further includes the design of tasks and instructional activities that encourage students to explain, demonstrate, describe, justify, and provide examples of their thinking processes (Teledahl, 2017).

Mathematical problem-solving skills consist of a combination of cognitive, behavioral, and attitudinal elements that are influenced by specific situations and rely heavily on an individual's knowledge and experience (Rittle-Johnson et al., 2009). These skills are gradually developed over time and represent important cognitive abilities that support the application of various tools and strategies in learning and problem situations (Molnár et al., 2013). In mathematics education, problem-solving skills are regarded as a fundamental competency that students need to acquire and strengthen (Greiff et al., 2013). The growth of mathematical problem-solving skills can vary according to several factors, including age, gender-related stereotypes, and differences in school environments or locations (Ayebele et al., 2020). Therefore, fostering the development of these skills has become a primary objective of educational systems, as these abilities equip students with essential competencies for future achievement and success (Uyen et al., 2021). Furthermore, mathematical problem-solving abilities can be enhanced through structured instruction, explicit training, and the use of enrichment materials designed to improve students' understanding and performance (Yeh et al., 2019). Teachers also need to understand how different student characteristics influence the development of mathematical problem-solving skills, enabling them to improve and adapt their instructional approaches effectively. Research conducted across several countries has shown that students from urban schools often demonstrate stronger mathematical performance and more advanced problem-solving skills than students in other settings (Nepal, 2017).

Nevertheless, findings from studies conducted in other countries have been inconsistent. Gender differences in mathematics achievement have also received significant attention from researchers, with some studies reporting that male students tend to perform better than female students in mathematics (Xie & Liu, 2023). This issue has attracted considerable interest from psychologists, sociologists, and educators. While some researchers suggest that biological factors, such as differences in brain structure, may contribute to these variations, sociologists argue that equal educational opportunities can reduce or eliminate such disparities. Given that previous findings remain inconclusive and research examining gender differences across school classes remains limited, further investigation into gender-related differences in mathematical problem-solving skills would provide valuable insights (Balducci, 2023).

Despite the global emphasis on developing mathematical problem-solving skills, empirical evidence indicates that students' performance in this area remains relatively low, particularly in educational contexts where teacher-centered approaches and procedural instruction still dominate learning. Large-scale assessments and various national studies consistently show that many students experience difficulties with non-routine, contextual mathematical problems that require reasoning, modeling, and interpretation rather than the direct application of formulas. Preliminary observations conducted in several junior high schools in West Seram Regency revealed that students encountered significant challenges in understanding contextual problems, translating real-life situations into appropriate mathematical models, and explaining their reasoning clearly and systematically. Most students tended to focus on obtaining final answers rather than demonstrating conceptual understanding or reflective thinking. These findings are consistent with international research indicating that students often struggle with higher-order problem-solving tasks and tend to rely heavily on memorized procedures rather than deep conceptual understanding (Gonsalves, 2024; Gebremeskel, 2025). Furthermore, previous studies have reported that mathematics anxiety, limited exposure to authentic and meaningful tasks, and insufficient contextualization of instructional materials significantly hinder students' problem-solving performance (Yarkwah et al., 2024; Alashwal & Barham, 2025). Such conditions highlight the urgent need for instructional approaches that meaningfully connect mathematical concepts with students' real-life experiences and socio-cultural contexts.

Student achievement in problem-solving is influenced by a variety of factors, including the pedagogical approach teachers employ during instruction. Despite the increasing use of educational technologies and diverse

instructional methods, teachers continue to play a central role in the teaching and learning process (Keiler, 2018). Although numerous strategies and techniques have been introduced to help students solve problems effectively, some educators still rely on traditional, teacher-centered instructional approaches. Such practices may limit conceptual understanding by providing insufficient opportunities for students to develop and apply higher-order thinking skills during the learning process (Leasa et al., 2016). Teachers are therefore required to implement instructional approaches that accommodate the strengths and learning needs of all students (Alhassan & Abosi, 2014). Educators need to recognize and address differences in students' learning styles and abilities in order to create effective learning experiences (Leasa et al., 2018). Consequently, teachers should adapt their instructional practices to students' needs and provide a variety of learning strategies that students can apply. At the same time, students should be encouraged to identify and select the most suitable strategy when attempting problem-solving tasks (Osman et al., 2018).

Furthermore, there is an increasing need to design instructional approaches that align with the principles and challenges outlined by constructivist theory (Lockey et al., 2021). Teaching methods and strategies should evolve to support 21st-century learning environments that are grounded in constructivist perspectives (Orak & Al-Khresheh, 2021). In mathematics learning, students are expected to construct their own understanding and cognitive structures actively. This perspective is not limited to Ireland; educators worldwide acknowledge the importance of enabling children to build meaningful knowledge that can be transferred and applied in real-life situations (Parker et al., 2022).

Since the late 1960s, the Netherlands has introduced a major reform in mathematics education known as Realistic Mathematics Education (RME). This educational approach views mathematics not merely as a body of established knowledge to be transmitted but rather as an activity in which learners actively participate in constructing understanding (Van Zanten & Van Den Heuvel-Panhuizen, 2021). RME emphasizes students' real-life experiences and everyday situations as the foundation for learning, positioning mathematics as an active process carried out by learners themselves (Laurens et al., 2018). Realistic Mathematics Education has become an influential instructional approach adopted in countries such as the Netherlands, the United Kingdom, and the United States (Makonye, 2014). Over time, its implementation has expanded to other regions, including Indonesia, where it is commonly referred to as Indonesian Realistic Mathematics Education (Revina & Leung, 2019). In conventional mathematics classrooms, instruction generally begins with the presentation of abstract concepts, followed by exercises, application tasks, and homework activities intended to reinforce students' understanding.

In contrast, RME applies contextual problems that can be connected and transformed into mathematical ideas, thereby assisting students in developing their mathematical competencies. Moreover, discussion, reflection, and engaging learning experiences play significant roles in constructing mathematical understanding. This approach is closely aligned with Freudenthal's perspective that mathematics should be regarded as a human activity closely linked to reality and socially meaningful contexts (Stemn, 2017). Through RME, learners are encouraged to reflect on and solve problems based on meaningful experiences. In many cases, school mathematics presents students with artificial word problems that fail to represent authentic applications of mathematics in everyday situations. Some learning tasks combine both realistic and unrealistic elements. Research findings indicate that students tend to show greater motivation when engaged with authentic questions than when merely exposed to realistic contexts (Vos, 2018). Consequently, real-world situations in RME function as a starting point and resource for learning and developing mathematical concepts. Students are expected to construct their own mathematical understanding with appropriate support and guidance from teachers (Sumirattana et al., 2017).

RME learning based on coastal potential aims to leverage it and provide real-world experiences in everyday life. Coastal potential is arranged into a real problem in mathematical teaching materials that students use as worksheets during the mathematics learning process. The activities of the coastal community can be compiled into teaching materials and student worksheets (LKPD). Understanding coastal problems is essential in containing them in student worksheets (LKPD). Therefore, students can be trained through contextualized coastal problem-solving activities and communicate mathematically, interactively, and verbally, using mathematical symbols or language related to the problems.

Furthermore, prior research on realistic mathematics education (RME) has demonstrated its effectiveness in improving students' mathematical achievement and problem-solving skills (Listiwati & Sabon, 2023; Altiner, 2024). However, most of these studies have not specifically integrated coastal cultural contexts as a primary learning foundation. Given that coastal communities characterize West Seram Regency, the absence of locally contextualized mathematical materials represents a significant gap. Therefore, a study that integrates coastal potential into RME is both theoretically and empirically important for addressing contextual learning needs and strengthening students' problem-solving competencies. In addition, it provides students with opportunities to develop their thinking, reasoning, communication, and creativity (Paredes et al., 2020). Problem-solving-based learning environments allow students to develop deep mathematical knowledge and will enable them to construct their mathematics (Guven & Cabakcor, 2013). Given the existing problems, the starting

point for realistic mathematics learning in each study has yet to make use of coastal potential, especially in efforts to improve problem-solving and mathematical communication skills. This research was conducted to realize a robust coastal community that inherits mathematical values and coastal local wisdom, and to ensure the availability of junior high school mathematics literature directly related to the context of coastal potential for instilling mathematical concepts. Based on the description provided, the objective of this study is to analyze the effect of RME on students' mathematical problem-solving abilities after receiving realistic learning based on coastal potential.

METHODS

This study employed a quasi-experimental pretest–posttest control-group design (Harris, 2006; Handley et al., 2021). The design was selected because intact classroom groups were used without random assignment of individual students. Two groups were involved in the study: an experimental group and a control group. Both groups were administered a pretest to measure students' initial mathematical problem-solving ability before the treatment was implemented. The experimental group received instruction through coastal potential–based realistic mathematics education (RME), while the control group was taught using conventional learning methods. After the instructional period, both groups were given a posttest to measure the improvement in students' problem-solving abilities. This design enabled the researchers to compare the effectiveness of the two instructional approaches in enhancing students' mathematical problem-solving skills. In this design, the experimental group was administered a pretest (O1), then the treatment (X), and finally a posttest (O2). The control group received a pretest (O3) and a posttest (O4) but did not receive the experimental treatment. The treatment (X) refers to the learning process using coastal potential–based realistic mathematics education (RME). O1 represents the pretest administered before the implementation of realistic learning based on coastal potential, while O2 represents the posttest administered after the treatment. Meanwhile, O3 refers to the pretest administered to the control group using conventional learning, and O4 represents the posttest administered after the conventional instructional process. This design allowed for a comparison of students' learning improvement between the experimental and control groups. The learning intervention focused on plane geometry, a part of the eighth-grade mathematics curriculum. The instructional treatment was conducted over four learning sessions, during which the experimental group received instruction using coastal potential-based RME, while the control group received conventional instruction.

The primary objective of this study was to comprehensively analyze the quality and extent of students' mathematical problem-solving abilities following the implementation of Coastal Potential–Based Realistic Mathematics Education (RME). This objective was grounded in the need to evaluate not only students' achievement outcomes but also the depth of conceptual understanding and the effectiveness of contextualized instructional approaches. Specifically, the study aims to: 1) determine whether there was a statistically significant difference in the improvement of problem-solving abilities between students who were taught using Coastal Potential–Based RME and those who received conventional instruction; 2) measure the effectiveness of the RME approach by calculating normalized gain (N-gain) scores to assess the magnitude of learning improvement; and 3) examine whether there were differences in the level of improvement among schools that implemented the intervention. Therefore, the study focused not only on comparing posttest achievement scores but also on evaluating the degree, consistency, and quality of learning progress across different educational contexts. The characteristics of each stage of students' problem-solving skills in addressing particular problems reflect their ability to understand the problem, develop a plan, implement appropriate strategies, and evaluate the solution. Based on Polya's framework, the indicators of problem solving consist of four main stages. The first stage is understanding the problem, in which students comprehend the questions or problems presented to them. The second stage is formulating a plan, where students determine appropriate methods or strategies to obtain a solution. The third stage is executing the plan, in which students apply the selected methods to solve the problem. The final stage is looking back, in which students review and recheck their answers to ensure the solutions obtained are correct.

The research was conducted in three junior high schools in West Seram Regency and involved 120 eighth-grade students across six intact classes. In each participating school, one class was assigned to the experimental group, which received Coastal Potential–Based Realistic Mathematics Education (RME), while the other class served as the control group and received conventional instruction. The selection of classes was carried out to ensure comparable academic characteristics between groups prior to the intervention. The research instruments consisted of: 1) a Lesson Plan (RPP) developed in accordance with the principles of RME and contextualized to coastal community activities; 2) Student Worksheets (LKPD) designed using authentic problems derived from coastal potential to facilitate meaningful mathematical exploration; and 3) a mathematical problem-solving test comprising five essay-type questions aimed at assessing students' abilities in understanding problems, devising plans, carrying out procedures, and reflecting on solutions. Prior to implementation, the lesson plans and worksheets were validated by three educational experts to ensure content validity, construct appropriateness, alignment with curriculum standards, and language clarity (Expert validators,

namely a mathematics education expert from Universitas Negeri Surabaya, a mathematics education expert from Universitas Pendidikan Indonesia, and an applied mathematics expert from Universitas Pattimura). Furthermore, the instrument has been tested on several junior high school students in Ambon City and West Seram Regency, with a validity of 0.623 and a reliability of 0.925. The data collected in this study included students' pretest and posttest scores, which were used to determine learning outcomes, as well as normalized gain (N-gain) scores representing the magnitude of improvement in students' mathematical problem-solving abilities after the intervention.

Data were analyzed using SPSS version 26.0. The first step in the analysis process involved applying descriptive statistics to identify the mean values, minimum and maximum scores, and the performance classifications of the pretest and posttest results. Prior to conducting hypothesis testing, prerequisite analyses were conducted to verify that the assumptions for parametric testing were satisfied. These analyses included a normality test using the Kolmogorov–Smirnov test and a homogeneity-of-variance test to assess consistency of variance across groups. After the results indicated that the data met the requirements for normality and homogeneity, an independent-samples t-test was employed to determine whether there were significant differences in learning improvement between the experimental and control groups. In addition, a One-Way ANOVA was performed to investigate differences in improvement across schools. The effectiveness of the implemented intervention was also assessed by calculating the average N-gain score, which was then classified into effectiveness categories: ineffective, moderately effective, or effective. Overall, these analytical procedures enabled a thorough assessment of the influence of Coastal Potential-Based RME on students' mathematical problem-solving abilities.

RESULT AND DISCUSSION

Table 1. Pretest and posttest results

Qualification	Value	Problem-Solving			
		Pretest		Posttest	
		RME	PK	RME	PK
Very High	$x > 90$	0	0	4	0
High	$75 < x \leq 90$	0	0	24	0
Medium	$60 < x \leq 75$	0	0	15	1
Low	$40 < x \leq 60$	0	0	15	16
Very Low	$x < 40$	60	60	2	43

Table 1 shows the effectiveness of mathematical communication, as measured by pretest and posttest scores, in students' problem-solving ability. In the pretest scores, both classes have the same number of meager qualifications, as many as 60 students, while no students have very high or low qualifications. On the problem-solving posttest, the qualifications for both classes varied. 4 learners achieved very high qualifications in RME classes, whereas this qualification was not found in conventional classes. Then, 24 learners got high qualifications in RME classes, while this qualification was not found in traditional classes.

Furthermore, there were 15 learners and 1 learner for medium qualifications for RME and conventional classes, respectively. Meanwhile, for low qualifications, there were 15 learners in RME and 16 in conventional classes, respectively. There were 2 learners in RME classes with very low qualifications, while 43 learners were in traditional classes. It can be concluded that the use of realistic learning based on coastal potential in experimental classes or classes taught with Coastal Potential-Based RME learning is quite effective and influences students' problem-solving and mathematical communication skills compared to control classes or classes taught with Conventional learning, which is not adequate. After the prerequisite test, it was stated that the data are usually distributed and homogeneous. Then, a test of differences in problem-solving using the Coastal Potential-Based RME learning class and the conventional method was conducted.

Table 2. Independent t-test results of problem-solving ability
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Class	Equal variances assumed	.258	.613	15.95	118	.000	47.06717	2.95170	41.22199	52.91235
	Equal variances are not assumed.			15.95	117.9	.000	47.06717	2.95170	41.22199	52.91235

Based on the results presented in Table 2, the significance value (Sig. 2-tailed) was found to be 0.000, which is lower than the significance level of 0.05. This result indicates a significant difference in the improvement in students' problem-solving abilities between the group taught using Coastal Potential-Based RME and the group receiving conventional instruction. Furthermore, beyond examining the overall improvement in problem-solving skills within the experimental group that received Coastal Potential-Based RME, an additional analysis was conducted to investigate differences in the enhancement of problem-solving abilities across individual schools. To determine these differences, a One-Way ANOVA test was employed.

Table 3. One-way ANOVA test results of differences in problem-solving ability

ANOVA Problem-Solving					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4275.558	2	2137.779	10.861	.000
Within Groups	11219.206	57	196.828		
Total	15494.764	59			

Based on the findings presented in Table 3, the significance values for the problem-solving abilities of the three classes—VIII-A of SMPN 1 West Kairatu, VIII-C of SMPN 1 Kairatu, and VIII-1 of SMPN 2 Kairatu—were 0.000 and 0.002, both of which are below the predetermined significance level of 0.05. These results indicate significant differences in the improvement of problem-solving abilities across the classes taught through Coastal Potential-Based RME. Furthermore, to identify which class demonstrated the greatest improvement in problem-solving performance after the implementation of Coastal Potential-Based RME, a post hoc analysis using the Least Significant Difference (LSD) test was subsequently conducted.

Table 4. LSD Test Results of the Effect of RME on Problem-Solving Ability

Multiple Comparisons						
Dependent Variable: Problem Solving						
LSD						
(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
VIII-A SMPN 1 West Kairatu	VIII-C SMPN 1 Kairatu	-15.55650*	4.43653	.001	-24.4405	-6.6725
	VIII-1 SMPN 2 Kairatu	4.01850	4.43653	.369	-4.8655	12.9025
VIII-C SMPN 1 Kairatu	VIII-A SMPN 1 Kairatu Barat	15.55650*	4.43653	.001	6.6725	24.4405
	VIII-1 SMPN 2 Kairatu	19.57500*	4.43653	.000	10.6910	28.4590
VIII-1 SMPN 2 Kairatu	VIII-A SMPN 1 Kairatu Barat	-4.01850	4.43653	.369	-12.9025	4.8655
	VIII-C SMPN 1 Kairatu	-19.57500*	4.43653	.000	-28.4590	-10.6910

*. The mean difference is significant at the 0.05 level.

Table 5. Data on the improvement of problem-solving skills

VIII-A SMPN 1 West Kairatu				VIII-C SMPN 1 Kairatu				VIII-1 SMPN 2 Kairatu			
X_{min}	X_{max}	$\bar{x}$	S	X_{min}	X_{max}	$\bar{x}$	S	X_{min}	X_{max}	$\bar{x}$	S
42,55	70,07	63,97	13,04	53,49	85,62	79,53	13,02	33,33	67,37	59,96	15,84

Based on the information presented in Tables 4 and 5, several conclusions can be drawn regarding the improvement in students' problem-solving abilities after the implementation of Coastal Potential-Based RME. First, a significant difference was identified in the improvement of problem-solving skills between students in class VIII-A of SMPN 1 West Kairatu and class VIII-C of SMPN 1 Kairatu. Second, a significant difference was also observed between class VIII-C of SMPN 1 Kairatu and class VIII-1 of SMPN 2 Kairatu. Third, differences in the enhancement of problem-solving abilities were found between class VIII-A of SMPN 1 West Kairatu and class VIII-1 of SMPN 2 Kairatu. Among these three classes, class VIII-C of SMPN 1 Kairatu achieved the highest average N-Gain score of 79.53. In comparison, the average N-Gain scores for class VIII-A of SMPN 1 West Kairatu and class VIII-1 of SMPN 2 Kairatu were 63.97 and 59.96, respectively. Overall, the findings indicate that students' problem-solving abilities improved across all three schools following the implementation of Coastal Potential-Based RME. However, the magnitude of improvement varied among the classes. Class VIII-C of SMPN 1 Kairatu demonstrated the greatest improvement, as reflected by its higher average N-Gain score compared with class VIII-A of SMPN 1 West Kairatu and class VIII-1 of SMPN 2 Kairatu. Similar patterns were also identified in mathematical problem-solving.

Another important finding of this study is that class VIII-C at SMPN 1 Kairatu had the highest N-Gain score among the experimental classes. Several pedagogical and contextual factors may influence this result. First, teacher-related factors may contribute to differences in learning outcomes. Teachers who are more experienced in facilitating discussion, guiding students in interpreting contextual problems, and implementing the stages of Realistic Mathematics Education tend to produce more effective learning environments. Effective facilitation allows students to explore mathematical ideas more actively and construct solutions collaboratively. Second, classroom conditions and learning environments may also influence students' improvement. Classes with more supportive learning climates, higher student engagement, and better student collaboration often show greater improvements in problem-solving abilities. In the context of RME learning, classroom interaction and discussion are essential because students are encouraged to explain their reasoning and compare different strategies in solving problems. Therefore, variations in classroom dynamics across schools may explain why class VIII-C achieved the greatest improvement. Third, students' initial readiness and familiarity with contextual learning tasks may also play a role. Students who are more accustomed to collaborative work and contextual problems may adapt more easily to the RME approach. As a result, they can benefit more from the learning process, leading to higher gains in problem-solving ability.

In classes where Coastal Potential-Based RME was implemented, teachers began the learning process by providing instructional stimuli through teaching materials that incorporated contextual examples drawn from the daily lives of coastal communities. These contextual situations helped students understand the concepts being taught more easily because the examples were closely related to their real-life experiences. Following this, teachers guided students through the stages of Coastal Potential-Based RME instruction to help them understand the learning procedures. Although some students initially struggled to understand the learning process, continuous teacher guidance helped them gradually become familiar with and understand the approach's stages. After students were introduced to the concept of Coastal Potential-Based RME, they were provided with worksheets and actively engaged in completing the assigned tasks while developing their understanding of the learning material. Through this learning approach, students had opportunities to apply and develop problem-solving skills by working with contextual problems related to situations commonly found in coastal community life. The study's findings indicate that Coastal Potential-Based RME was more effective at improving students' mathematical problem-solving abilities than conventional instructional methods. These findings are consistent with previous studies showing that RME implemented in rural contexts produced better outcomes than traditional learning approaches (Palinussa, 2013; Palinussa et al., 2021). Previous studies have also reported that RME contributes positively to students' mathematical beliefs, representations, and problem-solving abilities. Therefore, teachers are encouraged to adapt their instructional practices to incorporate RME and to involve students actively in learning activities and discussions. The RME approach provides students with opportunities to construct their own knowledge of the topics being studied. Students are encouraged to express their ideas and develop concepts through each stage of learning. During the learning process, many students generated different solution procedures while arriving at the same answers, indicating that they viewed knowledge construction as a process of personal discovery and conceptual development. Furthermore, the RME approach has been identified as one of the most effective methods for enhancing mathematical representation, beliefs, and problem-solving skills, particularly among students with high academic achievement (Yuanita et al., 2018).

Achieving high levels of mathematical problem-solving ability remains a complex challenge because each

student possesses different capacities and characteristics in solving mathematical problems. The improvement of these abilities is influenced by various factors, including classroom conditions, teachers' competencies, the instructional models applied, and educators' capability to manage the learning process effectively. Collaborative learning activities also play an important role, as students working in groups to develop learning outcomes can strengthen their understanding, while each stage of the learning process contributes to the enhancement of pedagogical skills (Muslimin et al., 2020). Mathematical problem-solving has long been a major focus in mathematics education and in educational research involving children. Numerous previous studies have investigated different aspects of the mathematical problem-solving process (Li et al., 2020). Problem-solving activities provide students with opportunities to apply their content knowledge while enabling teachers to gain insights into students' mathematical understanding and thought processes through observations of their mathematical performance (Charlesworth & Leali, 2012).

Furthermore, problem-solving is recognized as one of the most advanced cognitive processes individuals use in addressing various situations in life. Several studies have highlighted the significant role of problem-solving abilities in predicting psychological adaptation, mental well-being, and academic performance. These findings are consistent with research examining problem-solving skills among gifted secondary school students in Saudi Arabia, which aimed to identify differences in problem-solving abilities based on gender and grade level. The study involved a random sample of 187 gifted students and found no significant differences between male and female students in problem identification and decision-making skills (Al Dreyweish et al., 2024).

The findings indicated that students with strong mathematical abilities who participated in realistic mathematics learning integrated with ethnomathematical contexts demonstrated excellent levels of problem-solving performance. These students were able to explain their understanding of the problems clearly, determine suitable strategies, and implement appropriate procedures to arrive at accurate solutions (Nursyahidah et al., 2018). In addition, learning materials developed using the Realistic Mathematics Education (RME) approach are both practical and effective in enhancing students' problem-solving skills in mathematics (Nugraheni & Marsigit, 2021). Within the RME framework, mathematical activities are designed using concrete experiences and are connected to objects or situations encountered in everyday life, consistent with the approach's principles and characteristics. Reality serves as a fundamental principle in RME and functions as an essential component of mathematics learning. The primary objective of this approach is to encourage students to engage with and apply mathematics in meaningful situations actively. In RME, real-life contexts are not merely introduced at the final stage of learning; rather, they function as the foundation from which mathematical ideas emerge. Consequently, the development of mathematical understanding should originate from realistic situations and proceed through a process of mathematical abstraction rooted in real experiences (Sitorus & Masrayati, 2016). However, many students tend to develop misconceptions regarding mathematical problem-solving. For example, students often assume that every problem presented by a teacher can be solved using the available information and that all necessary details are explicitly provided in the problem statement.

Additionally, they may believe that every mathematical problem has only a single correct answer. These assumptions are considered implicit beliefs and classroom expectations commonly referred to as socio-mathematical norms (Xin & Zhang, 2009). Problem-solving has been recognized as an effective instructional strategy for helping students develop a deeper understanding of mathematical concepts. Teaching mathematics through problem-solving offers several advantages, including increasing students' interest and enjoyment in learning, promoting the development of mathematical thinking habits, and demonstrating the practical usefulness of mathematics in addressing a wide range of real-world problems (Ayuwanti et al., 2021). Therefore, the implementation of RME has contributed significantly to identifying and addressing students' alternative conceptions within the learning process (Barnes, 2004). Several pedagogical mechanisms can explain the effectiveness of coastal potential-based RME observed in this study. First, the use of authentic contexts enhances meaningful learning. When mathematical problems are connected to students' real-life experiences, such as coastal activities and local community practices, students can more easily understand abstract mathematical concepts. Authentic contexts enable learners to visualize mathematical situations and relate them to their daily lives, which strengthens conceptual understanding. Second, the collaborative, discussion-based nature of RME encourages students to develop reasoning skills. Through group work, students are required to explain their thinking, compare different solution strategies, and justify their answers. These activities promote deeper mathematical reasoning and allow students to construct knowledge collectively. Third, contextualization helps reduce cognitive load during learning. When problems are presented within familiar contexts, students can focus more on mathematical relationships rather than struggling to interpret abstract symbols or unfamiliar situations. As a result, cognitive resources can be directed toward reasoning and problem-solving processes. In coastal communities such as West Seram Regency, integrating the potential of the coast into mathematics learning also strengthens cultural relevance. Students perceive mathematics as meaningful and applicable to their everyday environment, which increases motivation and engagement during learning activities. Therefore, integrating coastal contexts into the RME framework provides both cognitive and motivational advantages that support the development of students' mathematical problem-solving abilities.

CONCLUSION

Based on the findings and the overall discussion of this study, it can be concluded that significant differences exist in students' mathematical problem-solving abilities between those who were taught through the Coastal Potential–Based Realistic Mathematics Education (RME) model and those who received conventional instruction. The comparison of these two instructional approaches was intended to examine their respective effects on students' mathematical performance. The results demonstrate that the Coastal Potential–Based RME approach has a stronger impact and greater effectiveness in improving students' problem-solving abilities than traditional teacher-centered learning methods. In addition, the findings reveal differences in the enhancement of both mathematical problem-solving and mathematical communication skills between students exposed to Coastal Potential–Based RME and those taught through conventional approaches. Students who experienced contextual learning integrated with coastal potential tended to exhibit higher participation, improved conceptual understanding, and stronger analytical abilities. This indicates that integrating mathematical learning with students' surrounding environments, particularly contexts related to coastal life, can facilitate meaningful learning experiences and strengthen students' capacity to solve mathematical problems in a more structured and effective manner. Based on these results, the Coastal Potential–Based RME model can be considered a promising alternative instructional approach for improving students' mathematical problem-solving skills. The practical implications of this study suggest that mathematics teachers and educators may adopt this model as an innovative strategy to support students' mathematical competencies, not only in problem-solving but also across other mathematical domains. Furthermore, this approach has the potential to be implemented at the secondary school level and adapted for broader educational contexts to promote more contextual and student-centered learning environments. Several limitations should be acknowledged in this study. The research focused solely on the problem-solving abilities of eighth-grade junior high school students and was limited to specific mathematical topics. Therefore, future studies are encouraged to examine the effectiveness of the Coastal Potential–Based RME model in improving other mathematical competencies and across different learning materials, educational levels, and additional variables, such as students' motivation, creativity, and critical thinking abilities. Expanding future investigations may provide a broader understanding of the effectiveness and applicability of this instructional model across diverse educational settings.

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