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Integrating Barus Coastal Culture into the Missouri Mathematics Project: Fostering Mathematical Numeracy through Web-Based Learning among Junior High School Students

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Abstract

This study aimed to develop and evaluate an integrated Missouri Mathematics Project (MMP) instructional model incorporating Barus Coastal Culture and supported by WordPress-based learning to enhance junior high school students' mathematical numeracy. Educational design research was conducted using the Plomp framework, comprising preliminary research, prototyping, and assessment phases. The final implementation involved 54 seventh-grade students from SMP Muhammadiyah 28 Barus and MTsN 1 Tapanuli Tengah. Data were collected through expert validation, practicality assessments, classroom observations, and mathematical numeracy tests administered before and after the intervention. The developed model consists of five instructional stages: review and culturally grounded motivation, concept development, group investigation, independent work and interaction, and assignment and reflection. The evaluation yielded a mean content validity score of 4.31 and a mean construct validity score of 4.20. The overall practicality score was 4.15, while classroom implementation reached 4.37. Students' mean mathematical numeracy scores increased from 68.57 (SD = 8.54) in the pretest to 81.91 (SD = 5.37) in the posttest, with an N-gain of 0.42, categorized as moderate. The Wilcoxon signed-rank test indicated a statistically significant within-group difference ($W = 28.50$, $p < .001$). Furthermore, 87.8% of student responses across the assessed items were classified as very good across the three numeracy indicators: the use of numbers and mathematical symbols, the analysis of information in different forms, and the interpretation of results for prediction and decision-making. These findings suggest that integrating local cultural contexts into the instructional architecture of MMP, supported by web-based learning, offers a promising approach to organizing contextual mathematics instruction. However, the observed improvement represents within-group change and does not establish a definitive causal effect of the model.

Keywords: Barus Coastal Culture, mathematical numeracy, Missouri Mathematics Project, culturally responsive mathematics learning, WordPress-based learning, educational design research

1. Introduction

Mathematics education is expected to develop students' capacity not only to perform mathematical procedures but also to understand, reason with, and apply mathematics in meaningful contexts (Craig, 2018). This expectation has shifted attention from instruction that emphasizes procedural proficiency toward learning experiences that enable students to connect mathematical ideas with authentic situations (Ulzana et al., 2026). Such connections are particularly important for junior high school students, as mathematical concepts become increasingly abstract while students continue to construct understanding through experience and social interaction. Accordingly, mathematics instruction requires pedagogical approaches that establish meaningful connections between formal mathematical knowledge and students' social and cultural environments without compromising mathematical rigor.

One established approach for structuring mathematics instruction is the Missouri Mathematics Project (MMP)(Hendri et al., 2025). Its historical foundation is associated with the Missouri Mathematics Effectiveness Project, which provided empirical evidence that structured mathematics instruction could improve students' academic achievement compared with conventional classroom practices (Good & Grouws, 1979). Subsequent empirical research has

demonstrated the contribution of MMP to students' mathematical literacy through structured mathematics instruction (Rahma et al., 2022). Other studies have examined the development of mathematics learning devices based on MMP for junior high school students (Lestari & Abdurrahman, 2022). Furthermore, the integration of cultural contexts into MMP has been explored as an alternative for enriching mathematics instruction and supporting students' learning motivation (Syaifudin et al., 2025). These findings indicate that MMP remains a relevant instructional framework; however, its pedagogical potential can be further expanded by incorporating students' cultural experiences into the organization of mathematics learning.

Although previous studies have demonstrated the relevance of MMP to mathematics education, the integration of cultural knowledge into the instructional architecture of the model remains an important area for further investigation (Ali, 2026). A structured instructional model may organize classroom activities systematically while still presenting mathematical situations that are disconnected from students' everyday experiences. Cultural responsiveness, therefore, requires more than incorporating local objects or traditional practices as illustrations in mathematical problems (Ladson-Billings, 1995). Rather, students' cultural experiences should function as meaningful resources for identifying problems, constructing mathematical representations, discussing alternative strategies, and interpreting results. In this regard, teachers' understanding of the cultural and ideological dimensions of students' mathematical thinking is essential for establishing meaningful classroom interactions (Louie, 2018). Consequently, the adaptation of MMP requires consideration of how cultural knowledge can inform learning activities, classroom interactions, teacher facilitation, and the supporting components of instruction (Nuraina et al., 2022).

Ethnomathematics provides a complementary perspective by examining mathematical ideas and practices embedded in cultural activities, artifacts, and community knowledge (Fajriyah, 2018). Through this perspective, cultural practices can serve as contextual resources for connecting students' informal experiences with formal mathematical concepts. Previous research has demonstrated the feasibility of developing ethnomathematics-based learning resources for junior high school students through evaluations of their validity, practicality, and effectiveness (Ristanti & Murdiyani, 2021). Nevertheless, the use of culturally contextualized learning materials does not necessarily constitute culturally responsive instruction. A more comprehensive approach requires cultural knowledge to be integrated into the pedagogical structure of learning so that it influences how students engage with mathematical concepts, interact with peers, and construct mathematical understanding.

This approach is particularly relevant to the Barus coastal community in North Sumatra, Indonesia, which possesses cultural practices and artifacts that provide authentic contexts for mathematics learning. These include traditional fishing activities, fish trading, coastal architecture, handicrafts, maritime activities, traditional fishing boats, and the Sikambang tradition. In the context of this study, Sikambang is associated with customary community events, including weddings and other important ceremonies, involving identifiable performance stages, spatial arrangements, and patterns of social interaction. These cultural practices offer opportunities to explore mathematical concepts related to measurement, geometry, quantity, comparison, and spatial reasoning. The Sikambang tradition has also been documented as an important element of the cultural identity of the coastal Sibolga Tapanuli Tengah community (Ruwaida, 2014). Integrating these cultural resources into mathematics instruction provides opportunities for students to recognize mathematical relationships within their surrounding environment and connect local experiences with formal mathematical representations (Wutsqa & Nugroho, 2026).

In addition to cultural integration, web-based learning provides opportunities to organize and facilitate mathematics instruction through accessible digital resources. Digital learning environments can support the presentation of instructional materials, contextual problems, exercises, and supplementary learning activities beyond the physical classroom. Previous research has demonstrated the feasibility of a web-based realistic mathematics learning environment for supporting mathematics learning and the development of twenty-first-century skills (Lisnani et al., 2023). However, the availability of a digital platform does not automatically establish the cultural responsiveness of mathematics instruction. Its educational contribution depends on how digital resources are aligned with instructional objectives, cultural contexts, learning activities, and teacher–student interactions. Accordingly, WordPress is positioned in this study as a supporting learning environment that facilitates access to culturally grounded mathematics resources and complements the classroom implementation of the developed instructional model.

Mathematical numeracy constitutes an important learning outcome in this study because it concerns students' ability to use numbers, symbols, mathematical representations, and information to solve problems in everyday contexts, analyze information presented in different forms, and interpret results to support prediction and decision-making (Pickering et al., 2025). In this study, mathematical numeracy is operationalized through three interrelated processes: understanding, application, and reasoning. These processes require students to identify relevant information, formulate mathematical

relationships, select and apply appropriate strategies, interpret results, and communicate conclusions. This conceptualization is consistent with recent literature emphasizing numeracy as the capacity to reason mathematically in contextual situations (Pratiwi et al., 2024).

The emphasis on mathematical numeracy is particularly relevant to culturally responsive mathematics instruction because culturally meaningful problems require students to connect real-world situations with formal mathematical representations. Through this process, students are encouraged to examine contextual information, construct mathematical models, apply appropriate procedures, and interpret their findings (Craig, 2018). Accordingly, the integration of Barus Coastal Culture into the developed learning model is intended to provide repeated opportunities for students to engage in understanding, application, and reasoning, thereby supporting the development of mathematical numeracy.

The instructional design of the developed model is supported by complementary theoretical perspectives, namely meaningful learning, experiential learning, social constructivism, and sociocultural learning. Meaningful learning emphasizes the relationship between newly acquired knowledge and students' relevant prior knowledge (Ausubel, 1960). This perspective provides a foundation for using familiar cultural contexts as initial resources for constructing mathematical understanding. Experiential learning emphasizes the importance of experience, reflection, conceptualization, and application in the learning process (Kolb, 1983). This perspective supports the progression from exploring cultural situations to developing mathematical concepts and applying them to contextual problems. Social constructivism emphasizes knowledge construction through interaction, discussion, and collaborative activities, whereas sociocultural learning recognizes that learning is situated within social practices and cultural environments. Collectively, these perspectives provide a theoretical foundation for integrating culturally situated problems, collaborative investigation, guided mathematical development, independent work, and reflection within the developed instructional model.

The relationships among the theoretical and instructional components are summarized in the conceptual framework presented in Figure 1. The framework illustrates how Barus Coastal Culture provides authentic contextual resources, MMP serves as the pedagogical framework, and WordPress functions as a supporting technological environment. These components are reinforced by teacher facilitation, collaborative learning, contextual scaffolding, reflection and discussion, and continuous assessment. Their integration is directed toward supporting mathematical numeracy through understanding, application, and reasoning.

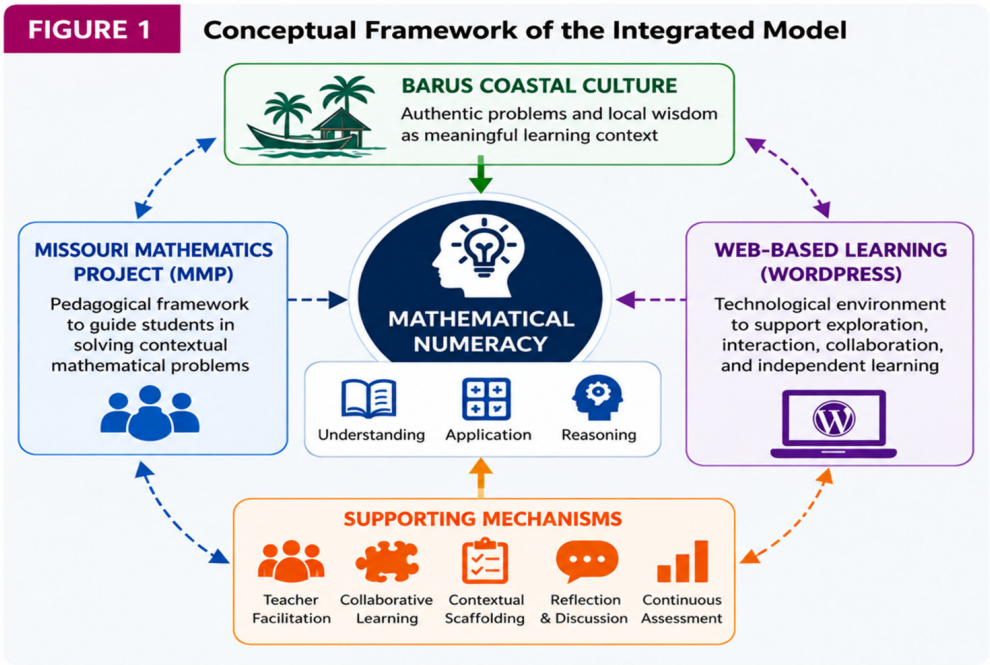


Figure 1. Conceptual Framework of the Integrated Missouri Mathematics Project Model for Enhancing Mathematical Numeracy

The existing literature therefore reveals three interrelated areas of research: structured mathematics instruction through MMP, culturally grounded mathematics learning through ethnomathematics and culturally responsive pedagogy, and digitally supported mathematics instruction. Although these areas have received research attention, their systematic integration at the level of an instructional model remains insufficiently addressed. In particular, further investigation is needed into how local cultural knowledge can be incorporated into the pedagogical architecture of an established mathematics instructional model, including its instructional syntax, social system, principles of teacher reaction, and supporting components. The integration of a web-based learning environment also requires consideration of its complementary role in facilitating the implementation of culturally grounded instructional activities. Addressing this gap requires an instructional model that positions cultural knowledge as an integral pedagogical resource rather than merely as supplementary content in mathematical problems.

The present study builds upon the authors' previous research on culturally responsive mathematics e-learning, which integrated the Sikambang tradition of the Barus coastal community through the WordPress platform (Simamora et al., 2026). The previous study primarily focused on developing a web-based learning environment that provided culturally contextualized mathematics materials and learning resources. In contrast, the present study extends this work by focusing on the development and evaluation of an integrated Missouri Mathematics Project (MMP) instructional model. Specifically, Barus Coastal Culture is incorporated not only as contextual content but also into the pedagogical architecture of the model, including its instructional syntax, social system, principles of teacher reaction, and supporting learning components. Accordingly, WordPress serves as a supporting technological environment within the instructional model, rather than as the primary product of the research. This distinction highlights the progression from developing culturally responsive digital learning resources to reconstructing an established mathematics instructional model through systematic cultural integration.

The novelty of this study lies in the systematic integration of Barus Coastal Culture into the pedagogical architecture of the Missouri Mathematics Project (MMP), supported by a web-based learning environment. Rather than merely using cultural examples as contextual illustrations in conventional mathematics instruction, the proposed model positions cultural knowledge as an integral part of the instructional design. This integration is reflected in the learning syntax, social interaction patterns, principles of teacher reaction, supporting learning resources, and the anticipated instructional and accompanying effects. The model is organized into five instructional stages: (1) Review and Culturally Grounded Motivation, (2) Concept Development, (3) Group Investigation, (4) Independent Work and Interaction, and (5) Assignment and Reflection. Across these stages, students' experiences and knowledge of Barus Coastal Culture are connected to structured mathematical activities, creating opportunities to develop contextual understanding, apply mathematical concepts, engage in reasoning, and reflect on their learning. The relationships among cultural integration, the MMP instructional components, and the learning process are illustrated in Figure 2.

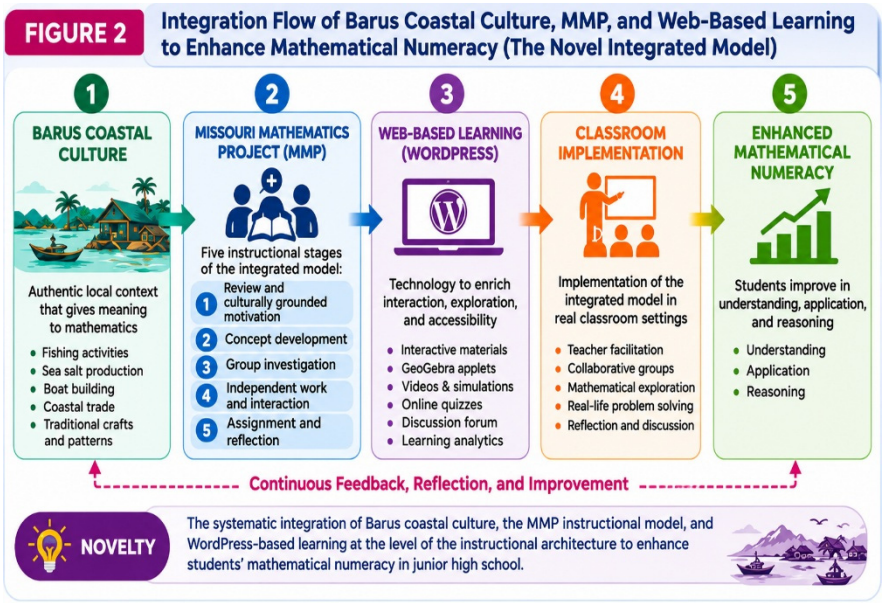


Figure 2. Integration Flow of Barus Coastal Culture, MMP, and Web-Based Learning to Enhance Mathematical Numeracy

Accordingly, this study aims to develop and characterize a culturally responsive Missouri Mathematics Project model that integrates Barus Coastal Culture and is supported by web-based learning for junior high school mathematics. The study examines the model's validity, practicality, and classroom implementation, as well as changes in students' mathematical numeracy following its implementation. Two research expectations guide the evaluation. First, the developed model is expected to demonstrate acceptable levels of validity and practicality and to be implementable in classroom settings. This expectation is examined through expert and practitioner assessments and classroom observations. Second, students are expected to demonstrate higher mathematical numeracy scores after implementation than before it. This expectation is examined using a one-group pretest–posttest design. Because the study does not include a comparison group, the observed score changes are interpreted as within-group improvement and should not be considered definitive evidence of a causal effect attributable exclusively to the developed model.

2. Method

2.1 Research Design

This study employed educational design research (EDR) guided by the Plomp framework (Plomp & Nieveen, 2007). The research process comprised three interconnected phases: preliminary research, prototyping, and assessment. The preliminary research phase involved analyzing the instructional context, relevant theoretical foundations, students' learning needs, and the potential of Barus Coastal Culture as a contextual resource for mathematics instruction. Particular attention was given to identifying cultural elements that could be meaningfully connected to mathematical concepts and students' learning experiences.

The prototyping phase focused on the iterative design, development, and refinement of the proposed culturally responsive Missouri Mathematics Project (MMP) model and its supporting instructional components. Formative evaluation was conducted through self-evaluation, expert review, one-to-one evaluation, and small-group trials. Feedback obtained throughout these activities informed successive revisions to the instructional syntax, integration of cultural contexts, and web-based learning components.

The assessment phase examined the validity and practicality of the developed instructional model, its implementation in authentic classroom settings, and preliminary evidence of changes in students' mathematical numeracy. The field implementation involved two Grade VII classes from MTsN 1 Tapanuli Tengah and SMP Muhammadiyah 28 Barus, comprising 54 students in total.

To examine changes in students' mathematical numeracy, a one-group pretest–posttest design was employed as part of the assessment phase. Students completed a mathematical numeracy test before and after the instructional intervention. Between the two assessments, students participated in four instructional sessions using the developed learning materials. The resulting paired scores were analyzed to identify within-group changes in mathematical numeracy performance. Since the study did not employ a comparison group, the findings were interpreted as evidence of changes following implementation rather than as definitive evidence of a causal effect attributable exclusively to the developed instructional model.

2.2 Participant and Research Setting

The study was conducted in the junior high school mathematics context of Tapanuli Tengah, North Sumatra, Indonesia. The final field implementation involved 54 Grade VII students from two schools: 30 students from SMP Muhammadiyah 28 Barus and 24 students from MTsN 1 Tapanuli Tengah. All participants engaged in mathematics learning on triangles and quadrilaterals using contextual problems derived from Barus Coastal Culture and the developed web-supported instructional model.

In addition to the final implementation participants, Grade VII students from MTs NU Barus were involved in the preliminary development trials. A separate group of 30 students participated in the pilot testing of the mathematical numeracy instrument. Expert and practitioner participants were involved in assessing the validity and practicality of the developed model and its supporting learning materials. The final statistical analysis included the 54 students who participated in the implementation at the two schools.

2.3 Sampling Procedures

Participants were selected using purposive sampling at the school level, followed by intact-class selection at the classroom level. This approach was adopted to ensure that the selected research settings were appropriate for the objectives and implementation requirements of the proposed instructional model.

Two junior secondary schools in Central Tapanuli Regency, Indonesia, were purposively selected: MTsN 1 Tapanuli

Tengah and SMP Muhammadiyah 28 Barus. The selection was guided by three criteria: (1) institutional characteristics, particularly school accreditation; (2) the availability of Grade VII classes and mathematics teachers; and (3) institutional readiness to implement technology-supported mathematics instruction through the WordPress platform.

At each school, one existing Grade VII class was selected as the implementation class. All students enrolled in these classes were included as participants. The final implementation sample consisted of 54 students, comprising 24 students from MTsN 1 Tapanuli Tengah and 30 students from SMP Muhammadiyah 28 Barus.

Students' prior mathematics achievement was considered when describing the participants' initial academic backgrounds and potential variation in mathematical ability; however, it was not included as a covariate in the primary statistical analysis.

2.3.1 Sample Size Considerations

The final field implementation involved 54 Grade VII students from two schools. The sample comprised 30 students from SMP Muhammadiyah 28 Barus and 24 students from MTsN 1 Tapanuli Tengah. The mathematical numeracy instrument was piloted with 30 students who were not included in the final implementation sample. No formal a priori statistical power analysis was conducted to determine the sample size. Accordingly, no retrospective power analysis was used as a substitute for an a priori justification. The precision of the estimated pretest–posttest change was assessed through the standard deviation and 95% confidence interval of the mean difference, as reported in the Results section.

2.4 Research Instruments and Measurement Quality

Data were collected using a set of instruments designed to assess the validity, practicality, implementation, and learning outcomes of the proposed instructional model. These instruments included model validation sheets, lesson plan validation sheets, student book validation sheets, student worksheet validation sheets, WordPress platform validation sheets, expert and practitioner assessment sheets for practicality, classroom implementation observation sheets, student response questionnaires, and a mathematical numeracy test.

The mathematical numeracy test was piloted with 30 students who were not part of the final implementation sample. The instrument yielded a Cronbach's alpha coefficient of .84, indicating satisfactory internal consistency. Item difficulty indices ranged from 0.35 to 0.72, while all item discrimination indices exceeded 0.30. These findings provided preliminary empirical evidence of the instrument's reliability and item quality.

In addition to the test scores, students' written mathematical solutions were examined using a structured analytical rubric covering six dimensions: consistency, systematicity, logical reasoning, accuracy, completeness, and structural organization or hierarchy. This rubric was used to provide supplementary descriptive information about the quality of students' mathematical reasoning and solution processes.

Formal inter-rater reliability was not calculated because paired ratings from independent raters were unavailable. Therefore, the analysis of written solutions was limited to descriptive interpretation rather than claims of inter-rater agreement.

No covariates were included in the primary pretest–posttest analysis. The quantitative analysis focused on examining changes in students' mathematical numeracy scores following the implementation of the proposed instructional model.

2.5 Instructional Intervention Procedures

The instructional intervention was implemented in one intact Grade VII class at each of the two participating schools: MTsN 1 Tapanuli Tengah and SMP Muhammadiyah 28 Barus. The implementation involved 54 students and consisted of four instructional sessions. Each session was allocated 45 minutes, corresponding to one instructional period in the participating schools. Throughout the four sessions, the five instructional stages were implemented sequentially in accordance with the procedures of the developed model.

The five instructional stages were operationalized as follows:

1. Review and Culturally Grounded Motivation. Learning activities began with a review of previously learned mathematical concepts, followed by motivational activities using contextual situations drawn from Barus Coastal Culture. These activities aimed to activate students’ prior knowledge and establish meaningful connections between their everyday cultural experiences and the mathematical concepts to be learned.

2. Concept Development. The teacher facilitated the development of mathematical understanding by connecting

culturally contextualized situations with mathematical concepts, representations, and formal explanations. Students were guided to identify mathematical properties, relationships, and principles embedded in contextual problems, particularly those related to triangles and quadrilaterals.

3. Group Investigation. Students worked collaboratively in groups to investigate and solve mathematical problems contextualized through Barus Coastal Culture. They explored relevant information, identified mathematical elements, discussed possible solution strategies, and compared their findings. Through this stage, students were encouraged to construct mathematical understanding collaboratively while developing their ability to communicate and justify their reasoning.

4. Independent Work and Interaction. Students independently completed mathematical tasks to strengthen their understanding and application of mathematical concepts. Opportunities for peer interaction, discussion, and feedback were also provided to encourage the exchange of mathematical ideas and clarification of solution strategies. This stage allowed students to apply the concepts developed during previous activities while maintaining opportunities for collaborative learning.

5. Assignment and Reflection. Students completed follow-up assignments related to the mathematical concepts and contextual problems explored during the instructional sessions. They also reflected on their learning experiences, reviewed their mathematical solutions, and formulated conclusions about the concepts studied. This stage emphasized the consolidation of mathematical understanding and the connection between formal mathematical concepts and the cultural contexts explored during instruction.

Barus Coastal Culture was integrated into the instructional activities through contextual elements associated with coastal fishing activities, coastal artifacts, and the Sikambang tradition. These cultural contexts were transformed into mathematical learning situations, particularly in tasks involving triangles and quadrilaterals. The integration aimed to provide meaningful contexts through which students could identify, represent, investigate, analyze, and apply mathematical concepts.

WordPress functioned as a supporting digital learning environment for accessing instructional materials, culturally contextualized mathematical problems, exercises, and supplementary learning resources. The platform was operated through the teacher’s device, while its learning content was made directly accessible to students during classroom activities. This arrangement enabled the teacher to facilitate technology-supported instruction while allowing students to engage directly with the digital learning resources.

2.6 Data Analysis

The collected data were analyzed descriptively and inferentially to evaluate the validity, practicality, classroom implementation, and students' mathematical numeracy.

Expert validation data were analyzed by calculating the mean scores for content validity and construct validity, including the validation scores for each instructional stage. Practicality assessment data and classroom observation results were analyzed descriptively using mean scores to evaluate the practicality and implementation of the developed model. The resulting scores were interpreted according to the predetermined evaluation criteria.

Students' mathematical numeracy test results were analyzed by calculating the pretest and posttest means and standard deviations. The normalized gain (N-gain) was calculated to describe the extent of improvement relative to the maximum possible gain and was interpreted using the applicable gain classification criteria.

Before conducting the paired inferential analysis, the normality of the paired difference scores was examined using the Shapiro–Wilk test. Because the paired difference scores did not meet the normality assumption, the Wilcoxon signed-rank test was employed to examine the statistical significance of the within-group difference between pretest and posttest scores. The rank-biserial correlation and standardized mean change (d_z) were also calculated to provide supplementary estimates of the magnitude of the observed change.

In addition, students' written responses were analyzed descriptively based on the three mathematical numeracy indicators: (1) the use of numbers and mathematical symbols to solve everyday problems, (2) the analysis of information presented in different forms, and (3) the interpretation of analytical results for prediction and decision-making. The number and percentage of responses reaching the very good category were calculated for each indicator and its corresponding item components. These descriptive results were used to identify students' relative strengths and areas requiring further instructional attention.

3. Results

3.1 Characteristics of the Developed Model

The developed instructional model integrates the pedagogical structure of the Missouri Mathematics Project (MMP), Barus Coastal Culture, and WordPress-supported learning. Barus Coastal Culture serves as a contextual and pedagogical resource that connects students' cultural experiences with mathematical concepts and learning activities. The model organizes the instructional process into five interconnected stages: (1) Review and Culturally Grounded Motivation, (2) Concept Development, (3) Group Investigation, (4) Independent Work and Interaction, and (5) Assignment and Reflection.

The first stage, Review and Culturally Grounded Motivation, activates students' prior mathematical knowledge and establishes connections between previously learned concepts and familiar situations in the Barus coastal community. Cultural contexts are used to stimulate students' interest and demonstrate the relevance of mathematics to their everyday experiences. The second stage, Concept Development, facilitates students' understanding of mathematical concepts through teacher explanations, contextual examples, and mathematical representations. In this stage, cultural situations are connected to formal mathematical concepts, particularly those related to triangles and quadrilaterals. The third stage, Group Investigation, provides opportunities for students to collaboratively explore culturally contextualized mathematical problems, identify relevant mathematical information, discuss solution strategies, and compare their findings. The fourth stage, Independent Work and Interaction, emphasizes individual problem-solving while maintaining opportunities for discussion, peer interaction, and feedback to strengthen students' understanding and mathematical reasoning. The fifth stage, Assignment and Reflection, consolidates learning through follow-up assignments and reflection on the concepts, strategies, and problem-solving processes experienced during the instructional activities.

In addition to the instructional syntax, the model comprises several interrelated supporting components. Its social system emphasizes student collaboration, teacher facilitation, mutual respect, and meaningful interactions grounded in local cultural contexts. The principles of teacher response position the teacher as a facilitator who provides appropriate guidance, questions, prompts, and feedback in response to students' learning needs and mathematical thinking. The supporting system consists of lesson plans, a model book, a student book, student worksheets, mathematical numeracy assessment instruments, and WordPress-based learning resources. These components support the systematic implementation of the five instructional stages and provide access to learning materials and contextual mathematical tasks. The model's intended instructional effect is the development of mathematical numeracy through students' ability to understand, apply, and reason mathematically in contextual situations. Its accompanying effects are expected to include collaboration, responsibility, communication, mutual respect, and appreciation of local culture.

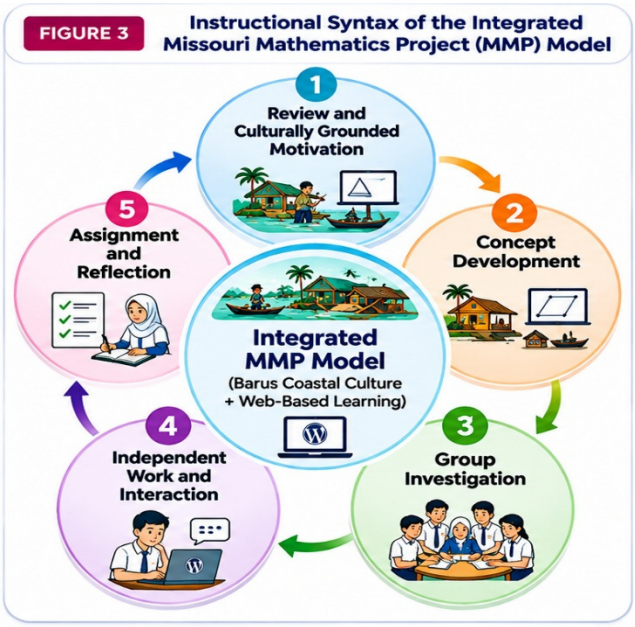


Figure 3. Instructional Syntax of the Integrated Missouri Mathematics Project Model

The instructional sequence of the developed model is presented in Figure 3. The figure illustrates the progression and interconnection of the five stages, from activating prior knowledge and providing culturally grounded motivation to developing concepts, conducting group investigations, engaging in independent work and interaction, and completing assignments and reflection. Together, these stages constitute the pedagogical structure that guides the implementation of the integrated MMP model.

Figure 4 presents the operational design of the developed model, showing how the five instructional stages are translated into classroom learning activities. It illustrates the integration of Barus Coastal Culture as a contextual resource, MMP as the pedagogical framework, and WordPress as the supporting web-based learning environment. The figure also presents the supporting learning components and the intended instructional and accompanying outcomes.

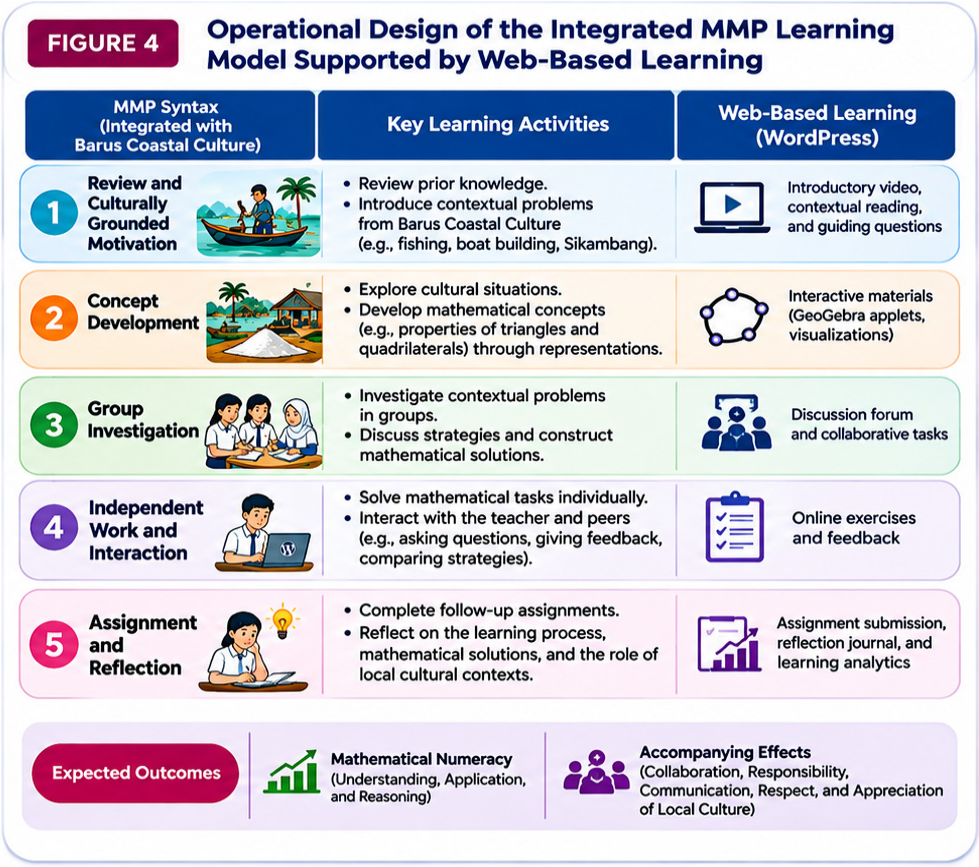


Figure 4. Operational Design of the Integrated Missouri Mathematics Project Model Supported by Web-Based Learning

The characteristics and components of the developed model are summarized in Table 1.

Table 1. Characteristics of the Developed Model

Model component	**Developed Characteristics**
Learning syntax	Review and Culturally Grounded Motivation; Concept Development; Group Investigation; Independent Work and Interaction; Assignment and Reflection
Social system	Collaborative student interaction, teacher facilitation, mutual respect, and culturally grounded group roles
Principles of reaction	Teacher acts as facilitator, provides prompts and feedback, and responds to students' mathematical thinking
Supporting system	Lesson plans, model book, student book, worksheets, numeracy test, and WordPress learning environment
Instructional effects	Development of mathematical numeracy through contextual understanding, application, and reasoning
Nurturant effects	Collaboration, responsibility, respect, communication, and appreciation of local culture
Cultural integration	Selected Sikambang functions are translated into orientation, group investigation, interaction, participation, and reflection within the MMP sequence.

3.2 Validity of the Developed Model

The validity evaluation examined the content and construct aspects of the developed instructional model. The assessment results produced a mean score of 4.31 for content validity and 4.20 for construct validity. Both scores met the validity criteria established for this study.

The assessment of the instructional syntax also indicated that all five stages met the established validity criteria. Review and Culturally Grounded Motivation obtained a mean score of 4.26, Concept Development 4.20, Group Investigation 4.12, Independent Work and Interaction 4.35, and Assignment and Reflection 4.08. Among the five stages, Independent Work and Interaction obtained the highest mean score, whereas Assignment and Reflection obtained the lowest mean score.

The detailed validation results are presented in Table 2.

Table 2. Validation Results of the Developed Model

Validation aspect	***Mean***	***Interpretation***
Content Validity	4.31	Valid
Construct Validity	4.20	Valid
Review and Culturally Grounded Motivation	4.26	Valid
Concept Development	4.20	Valid
Group Investigation	4.12	Valid
Independent Work and Interaction	4.35	Valid
Assignment and Reflection	4.08	Valid

3.3 Practicality and Classroom Implementation of the Developed Model

The practicality evaluation involved expert and practitioner assessments of the developed model. The overall mean practicality score was 4.15, which was classified as high according to the study's assessment criteria. The mean scores for the individual model components were 4.10 for the instructional syntax, 4.10 for the social system, and 4.26 for the principles of teacher reaction.

Classroom implementation was also evaluated through observations during the second trial. Classroom observations yielded a mean implementation score of 4.37, which was classified as high. Among the reported practicality and implementation indicators, classroom implementation obtained the highest mean score, followed by the principles of teacher reaction.

These findings indicate that the developed model and its instructional components could be implemented in the participating classroom settings according to the intended learning procedures. The practicality and classroom implementation results are presented in Table 3.

Table 3. Practicality and Classroom Implementation Results of the Developed Model

Practicality evidence	***Mean***	***Category***
Overall practicality assessment	4.15	High
Instructional Syntax	4.10	High
Social system	4.10	High
Principles of teacher reaction	4.26	High
Classroom implementation	4.37	High

3.4 Student Responses to the Learning Activities

Students' responses to the learning activities were evaluated during the small-group trial involving 25 students. A questionnaire consisting of 14 statements was administered using a four-point Likert scale: strongly agree (4), agree (3), disagree (2), and strongly disagree (1). The results showed that 284 responses (81.14%) were strongly agree, 64 responses (18.29%) were agree, and two responses (0.57%) were disagree. No responses were recorded in the strongly disagree category. Overall, 348 of the 350 responses (99.43%) were positive. The total weighted score was 1,333 out of a maximum possible score of 1,400 (95.21%). These findings indicate that students responded positively to the

learning activities and provided supplementary evidence regarding the acceptability of the developed model during the small-group trial.

3.5 Improvement in Students' Mathematical Numeracy

Changes in students' mathematical numeracy were examined through a one-group pretest–posttest assessment involving 54 Grade VII students. On the 0–100 score scale, the mean pretest score was 68.57 (SD = 8.54), whereas the mean posttest score was 81.91 (SD = 5.37). The mean score difference was 13.33 points (SD = 10.84), with a 95% confidence interval ranging from 10.38 to 16.29. The relative increase in the mean score was 19.45%.

The normalized gain (N-gain) was 0.42, which was classified as moderate. This value indicates a moderate improvement relative to the maximum possible score gain. The descriptive and inferential statistical results are summarized in Table 4.

Table 4. Statistical Result of Students' Mathematical Numeracy

Statistical Indicator	***Result***
Number of participants	54
Pretest mean (SD)	68.57 (8.54)
Posttest mean (SD)	81.91 (5.37)
Mean difference (SD)	13.33 (10.84)
95% confidence interval for mean difference	10.38–16.29
Relative mean increase	19.45%
N-gain	0.42 (moderate)
Shapiro–Wilk, difference scores	$W = 0.948$, $p = 0.020$
Wilcoxon signed-rank test	$W = 28.50$, $p < 0.001$
Rank-biserial correlation	0.959
Standardized mean change (d_z)	1.23

The normality of the paired difference scores (posttest minus pretest) was examined using the Shapiro Wilk test. The result was $W = 0.948$, $p = .020$, indicating that the difference scores did not meet the normality assumption. Accordingly, the Wilcoxon signed-rank test was used to examine the within-group change. The test yielded $W = 28.50$, $p < .001$, indicating a statistically significant difference between pretest and posttest scores. The rank-biserial correlation was 0.959, while the standardized mean change (d_z) was 1.23.

Taken together, the findings indicate a statistically significant within-group improvement in mathematical numeracy following implementation of the developed model. The N-gain indicates moderate improvement relative to the maximum possible gain, while the rank-biserial correlation and standardized mean change provide supplementary estimates of the magnitude of the observed change. However, because the study employed a one-group pretest–posttest design without a comparison group, the observed change cannot be interpreted as definitive evidence of a causal effect attributable exclusively to the developed model.

3.6 Students' Mathematical Numeracy Performance by Indicator

Students' mathematical numeracy performance was further examined based on three indicators: (1) the ability to use various numbers and mathematical symbols related to basic mathematics to solve everyday problems; (2) the ability to analyze information presented in different forms, such as graphs, tables, charts, and diagrams; and (3) the ability to interpret the results of problem analysis to make predictions and decisions.

Each indicator was represented by four item components. The first indicator comprised items 1a, 2a, 3a, and 4a; the second indicator comprised items 1b, 2b, 3b, and 4b; and the third indicator comprised items 1c, 2c, 3c, and 4c. Student responses were scored using a rubric ranging from 0 to 4. A score of 0 indicated no response, whereas scores from 1 to 4 represented progressively higher levels of response accuracy, from incorrect to correct answers. For the descriptive analysis, scores greater than 3 and up to 4 were classified as very good.

Across the 12 item components, 569 of the 648 possible student-item responses reached the very good category, representing 87.8% of the total responses. The results for each item component and participating school are presented in Table 5.

Table 5. Students' Mathematical Numeracy Performance by Item Component

Numeracy Indicator	*Indicator*	*SMP Muhammadiyah 28 Barus (n=30)*	*MTsN 1 Tapanuli Tengah (n=24)*	*Combined (%)*
Use of number and mathematical symbols	1a	30/30	24/24	100.0
	2a	30/30	24/24	100.0
	3a	30/30	24/24	100.0
	4a	30/30	23/24	98.1
Analysis of information in different forms	1b	25/30	22/24	87.0
	2b	28/30	24/24	96.3
	3b	25/30	23/24	88.9
	4b	24/30	20/24	81.5
Interpretation of results for prediction and decision-making	1c	25/30	22/24	87.0
	2c	30/30	24/24	100.0
	3c	19/30	16/24	64.8
	4c	12/30	15/24	50.0

Note. The very good category was defined as a rubric score greater than 3 and less than or equal to 4. The combined percentage represents the proportion of students achieving this category for each item component.

For the first indicator, students demonstrated consistently high performance in using numbers and mathematical symbols. All students achieved the very good category in item components 1a, 2a, and 3a, while item component 4a reached 98.1%.

For the second indicator, the proportions ranged from 81.5% to 96.3%, indicating that most students demonstrated very good performance in analyzing information presented in different forms. The highest proportion was observed in item component 2b (96.3%), while item component 4b showed the lowest proportion within this indicator (81.5%).

For the third indicator, the results varied more substantially. Item component 2c reached 100.0%, while item components 1c and 3c reached 87.0% and 64.8%, respectively. The lowest proportion across all 12 item components was observed in item component 4c, at 50.0%.

When aggregated by indicator, 215 of 216 responses (99.5%) for the use of numbers and mathematical symbols reached the very good category. For the analysis of information, 191 of 216 responses (88.4%) reached this category. For the interpretation of results for prediction and decision-making, 163 of 216 responses (75.5%) reached the very good category.

Overall, the descriptive analysis shows that most student responses reached the very good category, although performance varied across the three numeracy indicators. The highest proportion was observed in the use of numbers and mathematical symbols, whereas the interpretation of results for prediction and decision-making showed comparatively greater variation across item components.

4. Discussion

4.1 Model-Level Contribution: Integrating Culture into the Instructional Architecture

The main contribution of this study lies in reconstructing the Missouri Mathematics Project (MMP) through a culturally grounded instructional architecture that incorporates Barus Coastal Culture and WordPress-supported learning. Rather than treating local culture merely as an illustrative context for mathematical problems, the developed model positions culture as a resource that informs the organization of learning activities, student interaction, teacher facilitation, and reflection. MMP provides the pedagogical structure, Barus Coastal Culture provides meaningful contextual and social resources, and WordPress provides a technological environment to support access to learning materials and activities.

This integration extends the use of ethnomathematical contexts beyond the presentation of culturally relevant examples. Ristanti and Murdiyani (2021) demonstrated the development of ethnomathematics-based learning resources that met established quality criteria. The present study extends this direction by incorporating cultural considerations into the instructional architecture itself. Cultural contexts are connected to the five instructional stages, namely review and

culturally grounded motivation, concept development, group investigation, independent work and interaction, and assignment and reflection. Consequently, cultural integration is reflected not only in the mathematical content but also in how learning is organized and facilitated.

The model also maintains the pedagogical functions of MMP while adapting their implementation to the cultural and instructional context of the study. The sequence of concept development, collaborative investigation, independent work, and reflection provides a structured progression from contextual engagement toward mathematical reasoning. This reconstruction is consistent with the structured instructional orientation of MMP described by Good & Grouws (1979). The contribution of the present study, therefore, is not the replacement of MMP but its contextual reconstruction through the integration of cultural resources and web-based support.

The model should consequently be understood as an integrated instructional system rather than as a combination of three independent components. Barus Coastal Culture informs the contextual and social dimensions of learning, MMP organizes the pedagogical sequence, and WordPress supports the delivery and accessibility of learning resources. This distinction clarifies the model-level contribution and provides a basis for examining how culturally grounded learning can be systematically incorporated into mathematics instruction.

4.2 Barus Coastal Culture as a Mathematical and Pedagogical Resource

The integration of Barus Coastal Culture provides students with opportunities to encounter mathematical ideas through contexts associated with their local environment. Coastal activities and cultural practices can offer situations for exploring mathematical relationships, including measurement, geometry, quantity, comparison, spatial reasoning, and interpretation. Such contexts provide meaningful starting points for connecting students' everyday experiences with formal mathematical representations. This use of cultural practices as resources for mathematics learning is consistent with ethnomathematical perspectives that recognize mathematical ideas within community activities and cultural practices (Hartoyo, 2013).

The pedagogical value of cultural integration is not limited to contextual familiarity. When students work with problems derived from recognizable cultural situations, they are encouraged to identify relevant information, represent the situation mathematically, select appropriate strategies, and interpret their results. These activities create opportunities to move between informal contextual knowledge and formal mathematical reasoning. This approach is consistent with culturally responsive perspectives that recognize the relationship between students' cultural experiences and their engagement with mathematical ideas (Louie, 2018).

In the developed model, cultural contexts are incorporated into more than the initial motivation stage. They also provide a basis for concept development, group investigation, independent work, and reflection. During group investigation, students can exchange interpretations of contextual information and compare mathematical strategies. During independent work, they are expected to formulate and solve problems using appropriate mathematical representations. Reflection then provides an opportunity to reconsider the mathematical results in relation to the original context.

The collaborative dimension of these activities is also relevant to the accompanying effects intended by the model, including communication, responsibility, respect, and appreciation of local culture. However, these social outcomes should be interpreted as intended pedagogical effects rather than independently demonstrated empirical outcomes, because the present evaluation primarily focused on model quality, classroom implementation, and mathematical numeracy. Further research using specific measures of social and collaborative competencies would be needed to establish these outcomes empirically.

4.3 The Role of WordPress-Based Learning Support

WordPress functions as a supporting technological environment within the developed instructional model. It provides an organized space for presenting learning materials, culturally contextualized problems, exercises, and supplementary resources. Its role is to support students' access to instructional resources and to complement classroom activities, rather than to replace the pedagogical functions of MMP or the teacher's facilitation.

The integration of WordPress is meaningful because the developed model requires students to engage with contextual materials and mathematical tasks across different stages of learning. The web-based environment supports the presentation and accessibility of these resources, while the instructional sequence determines how students use them during learning. This distinction is important because the present study evaluates the integrated instructional model and does not isolate the independent contribution of WordPress to students' learning outcomes.

The use of web-based learning resources is consistent with research demonstrating the potential of web-based mathematics learning environments to support mathematics learning and the development of relevant competencies (Lisnani et al., 2023). Nevertheless, the findings of the present study do not establish that WordPress alone produced the observed improvement in mathematical numeracy. Its contribution should be understood as part of the supporting system that facilitates the implementation of the culturally responsive MMP model.

This interpretation also distinguishes the present study from the authors' previous research on culturally responsive mathematics e-learning through the WordPress platform. Simamora et al. (2026) focused on developing a digital learning environment integrating the Sikambang tradition of the Barus coastal community. In contrast, the present study advances the focus from the development of a web-based learning medium to the reconstruction of an instructional model. The distinction lies in the level of integration: the earlier work emphasized the learning environment, whereas the present model incorporates cultural considerations into the instructional syntax, social system, teacher-response principles, and supporting components.

4.4 Interpretation of Mathematical Numeracy Improvement

The final implementation showed an increase in the mean mathematical numeracy score from 68.57 (SD = 8.54) in the pretest to 81.91 (SD = 5.37) in the posttest. The mean difference was 13.33 points (SD = 10.84), while the N-gain was 0.42, indicating moderate improvement relative to the maximum possible gain. These descriptive results suggest that students demonstrated higher mathematical numeracy scores after participating in the instructional implementation.

The inferential analysis also indicated a statistically significant within-group change. Because the paired difference scores did not meet the normality assumption, the Wilcoxon signed-rank test was used, yielding $W = 28.50$ and $p < .001$. The rank-biserial correlation of .959 and standardized mean change of 1.23 provide additional estimates of the magnitude of the observed change. These statistics describe different aspects of the results: the Wilcoxon test evaluates evidence of paired change, the N-gain describes improvement relative to the maximum possible gain, and the standardized estimates provide supplementary information about the magnitude of within-group change.

The observed improvement can be discussed in relation to the learning opportunities provided by the developed model. Its five-stage instructional sequence connects students' prior knowledge and cultural experiences with structured mathematical activities. In particular, the Group Investigation stage provides opportunities for students to collaboratively examine culturally contextualized mathematical problems, identify relevant information, discuss possible solution strategies, and compare their findings. These activities create opportunities to engage with mathematical information and develop reasoning through interaction with peers. The subsequent Independent Work and Interaction stage provides opportunities for students to apply mathematical concepts individually while discussing their approaches and receiving feedback. This combination of individual problem-solving and interaction is intended to support students in developing their own mathematical reasoning while considering alternative strategies and explanations.

The Assignment and Reflection stage further consolidates the learning process by encouraging students to revisit mathematical concepts, examine their problem-solving procedures, and reflect on the meaning of their results in relation to the original contextual problems. Through this stage, students are encouraged not only to obtain numerical answers but also to consider whether their solutions are reasonable and relevant to the situations being investigated. These activities are aligned with the mathematical processes assessed in this study, particularly the use of numbers and symbols, analysis of information, and interpretation of results. Previous research has also reported contributions of MMP-oriented instruction to students' mathematical learning outcomes (Rahma et al., 2022).

The integration of Barus Coastal Culture provides contextual situations through which students can relate mathematical ideas to familiar experiences in their community, while WordPress-supported resources provide access to learning materials and mathematical tasks. Thus, the potential contribution of the model lies in the coordination of cultural contexts, the five-stage MMP instructional sequence, and web-based learning support. However, the present study did not examine the independent contribution of each instructional stage or the WordPress environment to students' score changes.

Nevertheless, the statistical findings should be interpreted within the limits of the research design. The study employed a one-group pretest–posttest design without a comparison group. Therefore, the significant within-group change cannot establish that the developed model alone caused the improvement or that it was superior to other instructional approaches. Other influences, including students' development over time, familiarity with the test format, and classroom-related factors, cannot be completely ruled out. The results consequently provide evidence of improvement following implementation in the participating classrooms, rather than definitive evidence of causal effectiveness.

4.5 Mathematical Numeracy Performance Across the Three Indicators

The descriptive analysis of students' written responses provides further insight into the three mathematical numeracy indicators assessed in this study. Overall, 569 of 648 student-item responses (87.8%) reached the very good category. However, the proportions differed across the three indicators, suggesting that students' performance was not uniform across the assessed mathematical processes.

The highest proportion was observed in the ability to use numbers and mathematical symbols to solve everyday problems, with 215 of 216 responses (99.5%) reaching the very good category. This result suggests that most students were able to use basic mathematical representations accurately in the assessed tasks. The contextual orientation of the developed model may have provided opportunities for students to connect familiar situations with mathematical operations and symbols. However, this interpretation should be considered in relation to the descriptive nature of the indicator analysis.

For the second indicator, the ability to analyze information presented in different forms, 191 of 216 responses (88.4%) reached the very good category. Although this proportion was lower than that of the first indicator, it indicates that most students demonstrated strong performance in working with information presented in the assessment tasks. Analyzing tables, graphs, diagrams, and other representations requires students to identify relevant information and establish relationships among the data. Such processes are important in contextual mathematical problem-solving.

The third indicator, which assessed students' ability to interpret analytical results for prediction and decision-making, showed a comparatively lower proportion of very good responses: 163 of 216 responses (75.5%). In particular, item component 4c reached 50.0%, while item component 3c reached 64.8%. These results indicate that interpreting mathematical findings and using them to formulate predictions or decisions remained more challenging for some students than using mathematical symbols or analyzing presented information.

This difference has an important instructional implication. Mathematical numeracy requires more than performing calculations or identifying information; students must also interpret the meaning of their results in relation to the original problem. Therefore, subsequent implementation of the model could place greater emphasis on asking students to justify their interpretations, explain the implications of numerical results, evaluate the reasonableness of their conclusions, and relate their decisions to the contextual situation. Such activities would strengthen the connection between mathematical procedures and meaningful decision-making.

The descriptive results should not be interpreted as evidence that students' performance improved separately in each indicator, because the analysis presented here reports the distribution of responses in the very good category rather than pretest–posttest changes for each indicator. Instead, the findings identify relative strengths and areas requiring further instructional attention within the final implementation.

4.6 Limitations, Implications, and Direction for Future Research

Several limitations should be considered when interpreting the findings. First, the final implementation involved 54 Grade VII students from two schools in the Barus coastal region. Although the participating schools provided implementation contexts for evaluating the model, the sample and geographical coverage limit the extent to which the findings can be generalized to other school settings and cultural communities. Further implementation involving schools with different institutional characteristics, student backgrounds, and geographical contexts is required to examine the model's transferability.

Second, the study used a one-group pretest–posttest design without a comparison group. Although the results showed statistically significant within-group improvement, the design does not allow the observed change to be attributed exclusively to the developed model. Future studies should employ comparison groups or stronger quasi-experimental designs to examine the contribution of the integrated model relative to other instructional approaches.

Third, the implementation involved students from two schools, but the statistical analysis did not incorporate school-level clustering. Differences in school context, classroom practices, and other institutional factors may have contributed to variation in student outcomes. Future research involving a larger number of schools should consider analytical approaches that account for the hierarchical structure of educational data.

Fourth, the N-gain of 0.42 was classified as moderate, indicating that there remains room for further improvement in students' mathematical numeracy. The descriptive analysis also showed comparatively lower performance in interpreting results for prediction and decision-making. Future refinement of learning activities should therefore provide more systematic opportunities for students to explain their reasoning, evaluate mathematical conclusions, and make decisions based on contextual information.

Fifth, the written-response analysis was reported descriptively based on the available assessment records. Formal inter-rater reliability was not established because paired ratings from independent raters were unavailable. Future studies should incorporate clearly documented scoring procedures, independent raters, and inter-rater reliability analysis to strengthen the evidence concerning students' written mathematical performance.

These limitations also point to several implications. For mathematics teachers, the model provides a structured way to connect local cultural contexts with mathematical concepts and problem-solving activities. Teachers can use familiar cultural situations as starting points for mathematical exploration while guiding students toward formal representations, collaborative investigation, independent practice, and reflection. For instructional designers, the findings illustrate the importance of aligning cultural resources, pedagogical syntax, teacher facilitation, and digital support within a coherent instructional architecture. For future researchers, the model provides a basis for examining culturally grounded mathematics instruction through broader samples, comparison conditions, longer implementation periods, and more comprehensive outcome measures.

Overall, the findings suggest that integrating Barus Coastal Culture into the instructional architecture of MMP, supported by a WordPress-based learning environment, offers a promising approach to organizing contextual mathematics learning. Its contribution lies in the systematic relationship among cultural context, pedagogical structure, and technological support. Further research is needed to establish its transferability and to examine its effects under more rigorous comparative research designs.

5. Conclusion and Suggestions

5.1 Conclusion

This study resulted in an integrated Missouri Mathematics Project (MMP) instructional model that incorporates Barus Coastal Culture and is supported by a WordPress-based learning environment. The model is organized into five interconnected instructional stages: (1) Review and Culturally Grounded Motivation, which connects students' prior mathematical knowledge with familiar cultural experiences; (2) Concept Development, which facilitates the understanding of mathematical concepts through contextual explanations and representations; (3) Group Investigation, which engages students in collaborative exploration and discussion of culturally contextualized mathematical problems; (4) Independent Work and Interaction, which provides opportunities for individual problem-solving, peer interaction, and feedback; and (5) Assignment and Reflection, which consolidates learning through follow-up tasks and reflection on mathematical concepts and problem-solving processes. The distinguishing contribution of the model lies in positioning Barus Coastal Culture as an integral element of the instructional architecture, encompassing the learning sequence, social interaction, principles of teacher reaction, and supporting learning resources, rather than using local culture merely as an illustrative context for mathematical problems.

The evaluation results indicated that the developed model met the established validity and practicality criteria. Content validity reached a mean score of 4.31, while construct validity reached 4.20. The overall practicality score was 4.15, and classroom implementation reached 4.37. These findings indicate that the model and its supporting components were considered suitable for implementation in the participating classrooms.

The implementation involving 54 Grade VII students showed an increase in the mean mathematical numeracy score from 68.57 (SD = 8.54) in the pretest to 81.91 (SD = 5.37) in the posttest, with an N-gain of 0.42, categorized as moderate. The Wilcoxon signed-rank test indicated a statistically significant within-group difference ($W = 28.50$, $p < .001$). Descriptive analysis further showed that 87.8% of student-item responses reached the very good category. Across the three numeracy indicators, the highest proportion was observed in the use of numbers and mathematical symbols (99.5%), followed by the analysis of information presented in different forms (88.4%) and the interpretation of results for prediction and decision-making (75.5%). These findings also identify interpretation and decision-making as areas requiring further instructional attention.

Overall, the findings suggest that the integrated model offers a promising instructional approach for connecting local cultural knowledge, structured mathematics instruction, and web-based learning support. Nevertheless, because the study employed a one-group pretest–posttest design without a comparison group, the observed improvement represents a within-group change following implementation and does not establish a definitive causal effect attributable solely to the developed model. Further research using comparative designs and broader implementation contexts is therefore needed to examine the model's effectiveness and transferability.

5.2 Suggestions

Based on the findings and limitations of the study, several suggestions are proposed.

First, mathematics teachers are encouraged to use culturally meaningful contexts as starting points for mathematical exploration and to connect these contexts with formal mathematical concepts and representations. In implementing the model, particular attention should be given to guiding students through the interpretation of mathematical results, prediction, and decision-making, as these processes showed comparatively lower performance in the assessment.

Second, schools are encouraged to support the implementation of culturally responsive mathematics learning by providing appropriate digital facilities, access to web-based learning resources, and opportunities for teachers to develop instructional materials grounded in local cultural contexts. WordPress can be used as a supporting environment for organizing and providing access to learning materials and mathematical activities.

Third, future researchers are encouraged to test the model using quasi-experimental or experimental designs involving comparison groups and a larger number of schools. Such studies would provide stronger evidence regarding the model's contribution to mathematical numeracy and its applicability across different educational contexts. Further research should also examine the development of students' numeracy performance across the three indicators separately, particularly their ability to interpret mathematical results and make decisions based on contextual information.

Finally, future model refinement should include longer implementation periods, more diverse cultural contexts, and additional measures of accompanying outcomes, such as collaboration, communication, responsibility, and cultural appreciation. Independent assessment and inter-rater reliability procedures should also be incorporated when evaluating students' written mathematical solutions.

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Author Statements

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Author Contributions

Yumira Simamora: Conceptualization, Methodology, Investigation, Formal analysis, and Writing – original draft.

Sahat Saragih: Supervision, Methodology, and Writing – review & editing.

Izwita Dewi: Supervision, Formal analysis, Writing – review & editing, and Corresponding author.

Consent for Publication

All authors have read and approved the final version of the manuscript and consent to its publication in the Journal of Curriculum and Teaching.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Permission to conduct the study was obtained from the participating schools. Informed consent was obtained from the parents or legal guardians of all participating students, who granted permission for their children to participate in the study. All students voluntarily agreed to participate in the research and take part in all stages of the study.

Ethics Approval

This study was conducted in accordance with applicable ethical principles for research involving human participants. Ethical approval was granted by the Research Ethics Committee of Universitas Alwashliyah Medan, Indonesia (Approval No. 004/R/KOMITE/V/2025, dated 30 May 2025).

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data will be shared while maintaining the confidentiality and privacy of the participating students.

Use of Artificial Intelligence

The authors used ChatGPT, an AI-based language model developed by OpenAI, to assist with language editing, grammar improvement, and manuscript refinement. All AI-generated suggestions were carefully reviewed and verified by the authors. The authors take full responsibility for the accuracy, integrity, and final content of the manuscript.

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