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Designing an ethnomathematics-based adaptive numeracy assessment model: Integrating the meda mazi cultural tradition in elementary mathematics education

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Abstract

Background: Conventional numeracy assessments often overlook students' cultural experiences and diverse learning abilities, highlighting the need for culturally responsive assessment approaches in elementary mathematics education.
Aims: This study aims to design an ethnomathematics-based adaptive numeracy assessment model integrating the Meda Mazi cultural tradition to support contextual mathematical reasoning among elementary school students.
Method: A descriptive qualitative approach was employed through a literature review examining numeracy assessment, adaptive assessment principles, ethnomathematics, and Meda Mazi cultural practices. Data were analyzed through reduction, thematic categorization, and interpretative synthesis to formulate a conceptual assessment framework.
Results: The study produced a conceptual model comprising three difficulty levels: basic, intermediate, and advanced. Mathematical contexts derived from Meda Mazi activities included participant grouping, resource distribution, time allocation, and logistical planning. The proposed adaptive mechanism progressively adjusts task difficulty based on students' responses while incorporating scaffolding to accommodate individual learning needs.
Conclusion: The proposed model offers a culturally contextualized framework for adaptive numeracy assessment that connects mathematical reasoning with local cultural practices. Further empirical investigation is necessary to establish its validity, practicality, and effectiveness in elementary mathematics education.

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INTRODUCTION

Numeracy literacy constitutes a fundamental competency in elementary mathematics education, enabling students to interpret quantitative information, apply mathematical concepts, and solve problems across diverse real-world situations. Beyond computational proficiency, numeracy encompasses mathematical reasoning, logical thinking, data interpretation, and evidence-based decision-making, which are essential for developing twenty-first-century competencies (González-Pérez & Ramírez-Montoya, 2022). The Organisation for Economic Co-operation and Development (OECD, 2023) emphasizes that mathematical literacy involves the ability to formulate, employ, and interpret mathematical knowledge in various personal, social, and practical contexts. Nevertheless, strengthening numeracy competencies remains a significant educational challenge, particularly in developing educational systems where mathematical instruction frequently prioritizes procedural calculations over conceptual understanding and contextual problem-solving. Findings from the

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Programme for International Student Assessment indicate that Indonesian students continue to perform below the OECD average in mathematical literacy, suggesting persistent difficulties in applying mathematical knowledge to unfamiliar and authentic situations (OECD, 2023). These challenges highlight the importance of developing assessment practices that move beyond conventional computational exercises toward evaluating students' capacity to interpret information, construct mathematical representations, and formulate appropriate solutions. Research on culturally responsive mathematics assessment suggests that students' sociocultural backgrounds and everyday experiences represent important considerations when designing meaningful and inclusive assessment instruments (Bahar & Maker, 2020; Ntumi et al., 2026). Similarly, culturally contextualized mathematical assessment has been recognized as a promising approach for connecting mathematical competencies with familiar situations while acknowledging diversity in students' learning experiences (Ntumi et al., 2026; Shanmugam et al., 2025). Consequently, integrating authentic contexts into numeracy assessment may provide students with more accessible opportunities to demonstrate mathematical understanding, reasoning abilities, and practical problem-solving competencies. Developing culturally responsive and contextually meaningful numeracy assessment models is therefore increasingly relevant to improving the quality and inclusivity of elementary mathematics education.

Ethnomathematics offers a theoretical foundation for recognizing mathematical concepts embedded within cultural traditions, community activities, and everyday social practices. From this perspective, mathematical knowledge is understood not merely as a collection of abstract principles but also as a culturally situated system of reasoning reflected in human interactions and traditional activities (Rodríguez-Nieto & Alsina, 2022; Umbara et al., 2021; Yeh et al., 2020). Previous research has demonstrated the educational relevance of ethnomathematics through the integration of local cultural heritage, traditional practices, and culturally meaningful mathematical problems into elementary mathematics learning (Musliana et al., 2024; Natih et al., 2024). Musliana et al. (2024) explored the mathematical potential of the historical Taman Mayura building as an ethnomathematical resource for developing elementary students' numeracy competencies. Similarly, Natih et al. (2024) reported positive student responses to numeracy problems incorporating Balinese cultural contexts, suggesting that culturally familiar situations can support students' engagement with mathematical tasks. Recent investigations have further examined ethnomathematics through digital learning environments, culturally contextualized instructional strategies, and project-based approaches, highlighting its expanding relevance to contemporary mathematics education (Ndeot et al., 2026; Wildaniati et al., 2026). Within the Ngada community of East Nusa Tenggara, Indonesia, the Meda Mazi tradition represents a customary deliberation practice involving collective discussion, mutual cooperation, shared responsibility, and community-based decision-making. Activities associated with this tradition, including organizing participants, distributing communal resources, allocating discussion time, and estimating logistical requirements, provide culturally meaningful situations involving arithmetic operations, measurement, proportional reasoning, and mathematical problem-solving. Furthermore, the communal values embedded in Meda Mazi are conceptually aligned with several dimensions of the Pancasila Student Profile, particularly mutual cooperation, independence, critical reasoning, creativity, and appreciation of cultural diversity (Kemendikbudristek, 2022). Accordingly, incorporating Meda Mazi into numeracy assessment offers an opportunity to connect formal mathematical competencies with indigenous cultural knowledge while supporting the development of culturally relevant educational experiences.

Adaptive assessment represents an important advancement in mathematics education because it enables assessment tasks to accommodate differences in students' mathematical understanding, learning readiness, and problem-solving abilities. Unlike conventional assessment

approaches that administer identical mathematical problems to all learners, adaptive assessment employs differentiated task difficulty and response-based progression to provide challenges corresponding to students' demonstrated competencies. This approach is particularly relevant to elementary mathematics education, where variations in numerical understanding, conceptual development, and mathematical reasoning require assessment practices that recognize individual learning differences. Previous studies have investigated adaptive diagnostic assessment as a strategy for identifying students' mathematical difficulties and supporting teachers in developing more responsive instructional practices (Alfageh et al., 2024). Similarly, examined adaptive game-based mathematics learning environments, while explored computerized adaptive assessment systems incorporating cognitive diagnosis to support personalized mathematical learning (Bang et al., 2023; Zhang et al., 2025). Developments in digital mathematics education have further emphasized the importance of integrating assessment technologies and differentiated instructional strategies to accommodate increasingly diverse learning needs (Weigand et al., 2024). Nevertheless, adaptive assessment principles can also be incorporated into non-digital assessment frameworks through structured difficulty levels, response-based task selection, and instructional scaffolding. When integrated with ethnomathematical contexts, these mechanisms may enable students to engage with mathematical problems that are simultaneously appropriate to their demonstrated abilities and meaningful within their sociocultural environments. Such integration is also consistent with the broader educational orientation of the Pancasila Student Profile, which emphasizes the development of critical reasoning, creativity, independence, cooperation, and respect for cultural diversity (Kemendikbudristek, 2022). Therefore, combining ethnomathematics and adaptive assessment principles provides a promising conceptual foundation for designing culturally contextualized numeracy assessment models that accommodate individual learning differences in elementary mathematics education.

Despite increasing scholarly interest in ethnomathematics, adaptive assessment, and culturally responsive mathematics education, the systematic integration of these approaches into a unified numeracy assessment framework remains insufficiently explored. Previous studies have highlighted the potential of ethnomathematics to enhance mathematical understanding through culturally contextualized learning, digital educational environments, and project-based instructional strategies (Ndeot et al., 2026; Wildaniati et al., 2026). Similarly, culturally responsive assessment research has emphasized the importance of incorporating indigenous knowledge, cultural diversity, and students' sociocultural experiences into mathematical assessment practices to promote inclusivity and meaningful learning (Bahar & Maker, 2020; Bennett, 2023; Ntumi et al., 2026; Shanmugam et al., 2025). Meanwhile, studies on adaptive mathematics assessment have primarily focused on diagnostic evaluation, computerized adaptive testing, and personalized learning technologies designed to accommodate individual differences in mathematical proficiency (Alfageh et al., 2024; Bang et al., 2023; Zhang et al., 2025). Although these studies provide valuable theoretical and methodological foundations, the reviewed literature offers limited explicit discussion of assessment models that systematically integrate ethnomathematical contexts, differentiated task difficulty, response-based progression, and instructional scaffolding within a culturally responsive framework. Furthermore, the Meda Mazi tradition of the Ngada community in Indonesia remains underexplored as a contextual foundation for designing adaptive numeracy assessments in elementary mathematics education. This indicates a theoretical gap concerning the integration of ethnomathematics and adaptive assessment principles, a methodological gap regarding the development of structured culturally contextualized assessment mechanisms, and a contextual gap related to the limited exploration of indigenous cultural practices as mathematical assessment resources. Addressing these gaps, the present study proposes an ethnomathematics-based adaptive numeracy assessment model that incorporates the Meda Mazi cultural tradition through three

progressive difficulty levels, response-based task adjustment, and conceptual scaffolding mechanisms. The proposed model contributes to elementary mathematics education by establishing a conceptual framework that connects cultural relevance, adaptive assessment design, and contextual mathematical reasoning, while providing a foundation for future empirical validation and classroom implementation.

This study aims to design an ethnomathematics-based adaptive numeracy assessment model by integrating the Meda Mazi cultural tradition into contextual assessment practices in elementary mathematics education. Specifically, the research seeks to identify mathematical concepts embedded in Meda Mazi cultural activities that can serve as meaningful contexts for assessing elementary students' numeracy competencies. These cultural activities include participant grouping, communal resource distribution, discussion time allocation, and logistical planning, which provide opportunities to explore arithmetic operations, measurement, estimation, proportional reasoning, and mathematical problem-solving. The study further aims to establish conceptual connections between these culturally situated mathematical practices and relevant numeracy indicators to ensure that the proposed assessment tasks reflect elementary mathematics learning objectives. Additionally, the proposed model organizes contextual numeracy tasks into three progressive difficulty levels, namely basic, intermediate, and advanced, to accommodate variations in students' mathematical understanding. Each difficulty level is conceptually designed to assess increasingly complex mathematical competencies, ranging from fundamental numerical operations to contextual interpretation, mathematical reasoning, and problem-solving. Another objective is to formulate an adaptive assessment mechanism that determines subsequent task difficulty based on students' responses while incorporating scaffolding activities when additional conceptual support is required. Beyond mathematical assessment, the study also seeks to identify conceptual relationships between the educational values embedded in Meda Mazi and the dimensions of the Pancasila Student Profile, particularly cooperation, independence, critical reasoning, creativity, and cultural appreciation. Through a descriptive qualitative approach and literature-based conceptual synthesis, this research is intended to contribute a structured framework that integrates ethnomathematical contexts, differentiated task design, and adaptive assessment principles into a coherent model. Ultimately, the proposed framework is expected to provide a theoretical foundation for developing culturally responsive numeracy assessment instruments and guiding subsequent investigations into their validity, practicality, and effectiveness in elementary mathematics education.

LITERATURE REVIEW

Numeracy assessment constitutes an essential component of elementary mathematics education because it provides systematic information about students' mathematical understanding, reasoning abilities, and capacity to apply quantitative knowledge in meaningful situations. Contemporary perspectives emphasize that numeracy extends beyond computational accuracy to include mathematical interpretation, problem formulation, representation, and evidence-based decision-making across diverse contexts (OECD, 2023). Accordingly, effective numeracy assessment should evaluate not only students' procedural knowledge but also their ability to interpret mathematical information and construct appropriate solutions to authentic problems. Traditional assessment practices frequently prioritize standardized mathematical exercises, which may provide limited opportunities for students to demonstrate contextual reasoning and alternative problem-solving strategies (Basid et al., 2024; Ferede et al., 2026; Nilimaa, 2023; Ukobizaba et al., 2021). In response, contextualized assessment approaches have gained attention because they connect mathematical concepts with situations that students encounter in their everyday environments.

Research examining ethnomathematics-oriented numeracy tasks suggests that culturally familiar contexts can facilitate students' engagement with mathematical problems and provide meaningful opportunities to demonstrate numerical understanding (Musliana et al., 2024; Natih et al., 2024). Furthermore, culturally responsive assessment perspectives emphasize the importance of recognizing students' linguistic, social, and cultural backgrounds when designing equitable mathematical assessment experiences (Bahar & Maker, 2020; Bennett, 2023). These considerations suggest that numeracy assessment should incorporate authentic mathematical situations while maintaining alignment with curriculum objectives and measurable competency indicators. Within elementary mathematics education, such an approach can potentially support the evaluation of arithmetic proficiency, proportional reasoning, mathematical representation, and contextual problem-solving through accessible assessment activities. Therefore, developing culturally contextualized numeracy assessment frameworks represents an important direction for connecting mathematical competency evaluation with students' lived experiences.

Ethnomathematics provides a theoretical perspective that recognizes mathematical knowledge as a culturally situated phenomenon expressed through traditional practices, community interactions, and everyday problem-solving activities. This perspective acknowledges that mathematical concepts emerge not only through formal instruction but also through cultural activities involving counting, measuring, organizing, estimating, and interpreting quantitative relationships (de Freitas & Sinclair, 2020; Kabuye Batiibwe, 2024). Integrating ethnomathematics into elementary mathematics education can provide opportunities for students to recognize mathematical principles within familiar cultural environments while developing connections between informal knowledge and formal mathematical representations. Previous investigations have explored the educational potential of ethnomathematics through culturally contextualized instructional materials, traditional architectural structures, and mathematical activities derived from indigenous practices (Musliana et al., 2024; Natih et al., 2024). Musliana et al. (2024) examined the mathematical characteristics of the historical Taman Mayura building and their relevance to developing elementary students' numeracy competencies. Similarly, Natih et al. (2024) investigated students' responses to ethnomathematics-oriented numeracy problems incorporating Balinese cultural contexts, indicating the potential value of culturally meaningful assessment tasks. More recent studies have extended ethnomathematics research toward digital educational environments, culturally responsive instructional strategies, and project-based mathematical learning (Ndeot & Hartati, 2026; Mumu et al., 2026; Wildaniati et al., 2026). These developments suggest that ethnomathematics can function as more than a contextual teaching approach by providing conceptual resources for designing mathematical assessment tasks that reflect students' sociocultural experiences. Nevertheless, transforming cultural practices into assessment instruments requires careful identification of mathematical concepts, alignment with competency indicators, and consideration of task complexity to maintain educational relevance. Consequently, ethnomathematics-based numeracy assessment should establish explicit relationships between cultural authenticity, mathematical content, and the competencies being evaluated.

Adaptive assessment represents an assessment approach designed to accommodate individual differences in students' mathematical proficiency by adjusting task difficulty according to demonstrated performance. Rather than presenting identical assessment items to all learners, adaptive approaches employ differentiated tasks and response-based progression to provide assessment experiences that correspond to students' current levels of understanding. Research on adaptive mathematics assessment has explored diagnostic evaluation, computerized adaptive testing, and personalized learning environments as mechanisms for identifying students' mathematical competencies and learning difficulties (Bang et al., 2023; Alfageh et al., 2024; Zhang et al., 2025). These approaches demonstrate the potential of adaptive assessment to generate more

individualized information about mathematical understanding while supporting differentiated instructional decision-making. The conceptual foundation of adaptive assessment can be associated Zone of Proximal Development, which emphasizes the importance of appropriately challenging learning experiences supported by instructional assistance. Within elementary mathematics education, adaptive assessment can be organized through progressively differentiated tasks that assess fundamental arithmetic operations, contextual interpretation, and increasingly complex mathematical reasoning. A response-based progression mechanism may allow students who demonstrate sufficient understanding to encounter more challenging problems while directing those experiencing difficulties toward additional support or less complex tasks. Although computerized systems provide sophisticated mechanisms for adaptive item selection, non-digital assessment models may also incorporate structured difficulty levels and predefined decision rules to accommodate variations in students' mathematical abilities (Alothman et al., 2026; Burke, 2025; Ramos Pando et al., 2026). Nevertheless, the effectiveness of adaptive assessment depends on the appropriateness of task difficulty, the quality of assessment indicators, and the validity of the mechanisms used to interpret student responses. Therefore, integrating adaptive assessment principles into ethnomathematics-based numeracy assessment requires a coherent framework connecting mathematical competency indicators, culturally contextualized tasks, differentiated difficulty levels, and response-based scaffolding.

Culturally responsive mathematics assessment emphasizes the importance of designing assessment practices that acknowledge students' cultural identities, social experiences, and community-based knowledge as meaningful resources for mathematical understanding. This perspective challenges assessment approaches that treat mathematical competence as independent of the linguistic, cultural, and contextual conditions influencing students' interpretation of mathematical problems. Previous studies have highlighted the relevance of culturally responsive educational practices for supporting inclusive mathematics learning and recognizing diverse forms of mathematical knowledge (Bahar & Maker, 2020; Bennett, 2023; Shanmugam et al., 2025; Ntumi et al., 2026). Within the Indonesian educational context, integrating local cultural knowledge into mathematical activities also provides opportunities to connect numeracy competencies with the educational values reflected in the Pancasila Student Profile (Kemendikbudristek, 2022). The Meda Mazi tradition of the Ngada community in East Nusa Tenggara represents a customary deliberation practice involving collective discussion, mutual cooperation, shared responsibility, and communal decision-making. Its associated activities, including participant organization, resource distribution, discussion time allocation, and logistical planning, offer potential mathematical contexts involving numerical operations, measurement, estimation, proportional reasoning, and problem-solving. These cultural practices can be transformed into contextual assessment situations in which students interpret quantitative information, formulate mathematical relationships, and evaluate alternative solutions to practical problems. Furthermore, the communal characteristics of Meda Mazi provide conceptual connections with educational values such as cooperation, independence, critical reasoning, creativity, and respect for cultural diversity. However, the educational relevance of these cultural contexts depends on their accurate representation, alignment with mathematical learning objectives, and suitability for students' developmental characteristics. Accordingly, incorporating Meda Mazi into numeracy assessment requires a culturally sensitive design process that preserves the meaning of indigenous practices while translating them into mathematically meaningful and developmentally appropriate assessment tasks.

The integration of ethnomathematics and adaptive assessment principles offers a conceptual direction for developing numeracy assessment models that accommodate individual learning differences while maintaining meaningful connections with students' cultural environments. Existing ethnomathematics research has demonstrated the potential of culturally contextualized

mathematical activities, whereas adaptive assessment studies have emphasized differentiated task progression and individualized competency evaluation (Musliana et al., 2024; Natih et al., 2024; Bang et al., 2023; Alfageh et al., 2024; Zhang et al., 2025). Combining these perspectives requires an assessment framework that explicitly connects cultural contexts, mathematical competency indicators, task difficulty, and response-based assessment decisions. In the proposed model, the Meda Mazi tradition serves as the contextual foundation for constructing numeracy problems involving participant grouping, resource allocation, time management, and logistical decision-making. These mathematical situations are conceptually organized into three progressive difficulty levels comprising basic numerical operations, intermediate contextual interpretation, and advanced mathematical reasoning and problem-solving. The adaptive mechanism is designed to adjust subsequent task difficulty according to students' responses, allowing progression toward more challenging mathematical problems when sufficient understanding is demonstrated. Conversely, students encountering difficulties are directed toward less complex tasks or additional scaffolding intended to support their mathematical understanding. This structure reflects the conceptual integration of culturally responsive assessment, differentiated mathematical task design, and adaptive progression rather than an empirically validated assessment system. Furthermore, the proposed framework establishes potential connections between contextual mathematical reasoning and the educational values associated with the Pancasila Student Profile without assuming that assessment participation independently produces measurable character development. Therefore, the integration of Meda Mazi cultural contexts and adaptive assessment principles provides a conceptual foundation for subsequent instrument development, expert validation, classroom implementation, and empirical evaluation in elementary mathematics education.

METHOD

Research Design

This study employed a descriptive qualitative research design using a literature-based approach to develop a conceptual ethnomathematics-based adaptive numeracy assessment model integrating the Meda Mazi cultural tradition into elementary mathematics education. The qualitative approach was selected to facilitate a comprehensive examination of theoretical perspectives, educational practices, and cultural contexts relevant to numeracy assessment development. Rather than conducting experimental interventions or measuring learning outcomes, the research focused on identifying, interpreting, and synthesizing existing knowledge to establish a theoretically grounded assessment framework. The study integrated three principal conceptual domains, namely ethnomathematics, adaptive numeracy assessment, and culturally responsive mathematics education. Ethnomathematics provided the theoretical foundation for identifying mathematical concepts embedded in local cultural practices, while adaptive assessment principles informed the organization of differentiated assessment tasks according to students' mathematical abilities. Culturally responsive assessment perspectives were incorporated to ensure that the proposed model acknowledged students' sociocultural backgrounds and everyday experiences. The Meda Mazi tradition of the Ngada community in East Nusa Tenggara, Indonesia, was selected as the cultural context because its communal activities offer potential mathematical applications involving numerical operations, resource distribution, time allocation, and problem-solving. The conceptual model was designed to incorporate three progressive difficulty levels, namely basic, intermediate, and advanced, supported by a response-based mechanism for adjusting task complexity. The study did not involve experimental manipulation, classroom implementation, or statistical evaluation of assessment effectiveness. Accordingly, the research was positioned as an initial conceptual design

study intended to establish a theoretical foundation for subsequent instrument development, expert validation, and empirical investigation.

Participants

This study did not involve direct human participants because the research was conducted through a literature-based descriptive qualitative approach. The primary units of analysis consisted of scholarly publications, academic books, educational policy documents, and relevant literature addressing numeracy assessment, adaptive assessment, ethnomathematics, local cultural practices, and the Pancasila Student Profile. Elementary school students were identified as the intended beneficiaries of the proposed assessment model rather than participants in an implemented educational intervention. The educational context was specifically directed toward elementary mathematics education within the sociocultural environment of the Ngada community in East Nusa Tenggara, Indonesia. The selection of this context was based on the potential relevance of the Meda Mazi cultural tradition to mathematical activities involving counting, measurement, estimation, resource allocation, and collective decision-making. The literature examined in this study provided conceptual information concerning students' mathematical competencies, culturally responsive assessment practices, and differentiated assessment principles. Relevant educational policy documents were also considered to establish conceptual alignment between the proposed assessment model and the dimensions of the Pancasila Student Profile. Because the study did not include classroom observations, student assessments, or interviews, no participant recruitment procedures, sampling techniques, or demographic characteristics were reported. Consequently, the proposed assessment framework was developed exclusively through the interpretation and synthesis of existing literature rather than primary empirical data. Future research involving elementary school students, teachers, mathematics education experts, and local cultural representatives is necessary to evaluate the model's cultural appropriateness, validity, practicality, and educational effectiveness.

Instruments and Data Collection

Data collection was conducted through a literature review involving the identification, selection, and examination of scholarly sources relevant to the development of an ethnomathematics-based adaptive numeracy assessment model. The reviewed materials included national and international journal articles, academic reference books, educational policy documents, and publications discussing numeracy competencies, adaptive assessment, ethnomathematics, local cultural knowledge, and the Pancasila Student Profile. Sources were selected based on their thematic relevance, academic credibility, and publication recency to establish a comprehensive theoretical foundation for the proposed assessment framework. Particular attention was given to publications addressing contextual numeracy assessment, differentiated mathematical tasks, culturally responsive education, and the integration of indigenous knowledge into mathematics learning. The literature review also examined relevant educational policy documents to identify competency expectations and educational values associated with elementary mathematics education in Indonesia. A literature analysis matrix was conceptually organized around five thematic categories, including numeracy competencies, adaptive assessment characteristics, ethnomathematical practices, Meda Mazi cultural values, and the dimensions of the Pancasila Student Profile. Information extracted from the reviewed literature was classified according to its relevance to mathematical concepts, assessment difficulty levels, cultural contexts, and potential adaptive assessment mechanisms. Cultural descriptions associated with Meda Mazi were examined to identify mathematical situations involving participant grouping, resource distribution, discussion time allocation, and logistical planning. These mathematical situations were subsequently considered as potential contexts for developing assessment tasks aligned with elementary numeracy competencies.

The collected information served as the primary basis for constructing the proposed assessment framework rather than generating empirical measurements of students' mathematical performance.

Data Analysis

The collected literature was analyzed using descriptive qualitative analysis involving data reduction, thematic organization, data presentation, and conclusion drawing. Data reduction was conducted by identifying and selecting information directly relevant to numeracy assessment, adaptive assessment principles, ethnomathematics, Meda Mazi cultural practices, and the Pancasila Student Profile. Relevant information was subsequently categorized into thematic groups to facilitate systematic interpretation and conceptual comparison across the reviewed sources. The first analytical category focused on numeracy competencies, including numerical operations, mathematical interpretation, estimation, proportional reasoning, and contextual problem-solving. The second category examined adaptive assessment characteristics, particularly differentiated task difficulty, response-based progression, and instructional scaffolding. The third category explored ethnomathematical principles and their potential application in transforming culturally situated activities into contextual mathematical assessment tasks. The fourth category addressed mathematical concepts embedded in Meda Mazi cultural practices, while the fifth examined potential connections between culturally contextualized numeracy assessment and the dimensions of the Pancasila Student Profile. Following thematic classification, the identified concepts were synthesized to establish relationships among cultural contexts, mathematical competency indicators, assessment difficulty levels, and adaptive progression mechanisms. The findings were presented through descriptive explanations and a conceptual assessment structure comprising basic, intermediate, and advanced difficulty levels. Conclusions were subsequently formulated to establish the theoretical characteristics of the proposed model and identify considerations for future empirical validation.

Research Procedure

The research procedure was organized into five interconnected stages comprising literature identification, thematic exploration, mathematical competency mapping, adaptive assessment model design, and conceptual synthesis. The first stage involved identifying and examining relevant academic literature addressing numeracy assessment, ethnomathematics, adaptive assessment principles, culturally responsive mathematics education, and the Pancasila Student Profile. The second stage focused on exploring mathematical concepts potentially embedded in the Meda Mazi cultural tradition, particularly activities involving participant organization, resource distribution, discussion time allocation, and logistical planning. These cultural activities were interpreted as potential mathematical contexts involving arithmetic operations, measurement, estimation, proportional reasoning, and contextual problem-solving. The third stage involved mapping the identified mathematical concepts onto elementary numeracy competency indicators to establish alignment between cultural contexts and mathematical learning objectives. Based on this mapping, assessment tasks were conceptually organized into three progressive difficulty levels comprising basic numerical operations, intermediate mathematical interpretation, and advanced reasoning and problem-solving. The fourth stage involved designing a response-based adaptive mechanism in which students demonstrating sufficient mathematical understanding could progress toward more challenging tasks, while those experiencing difficulties could receive simpler supporting tasks or additional scaffolding. This mechanism was conceptualized as a differentiated assessment procedure that could be implemented without requiring computerized adaptive testing technology. The fifth stage involved synthesizing the identified theoretical principles, mathematical competencies, cultural contexts, and adaptive assessment characteristics into an integrated conceptual framework. The resulting model was proposed as an initial ethnomathematics-based adaptive numeracy

assessment framework requiring further expert validation, classroom implementation, and empirical evaluation to establish its validity, practicality, and effectiveness.

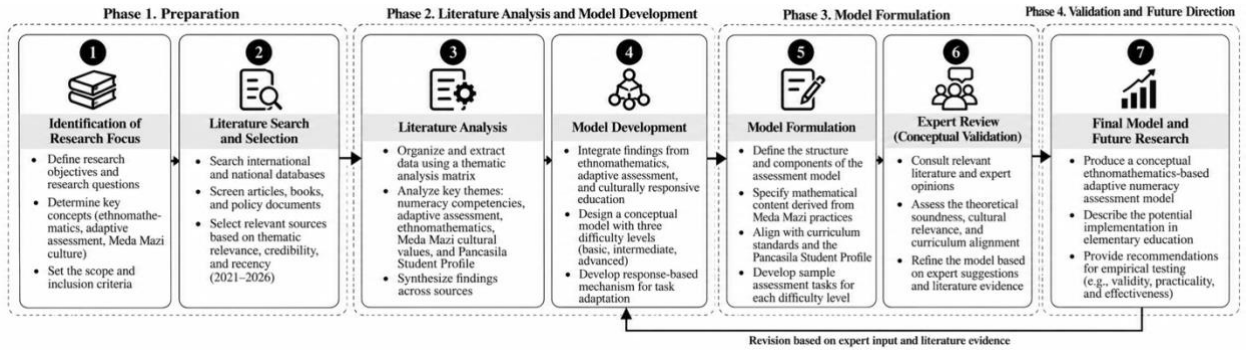


Figure 1. Research Method Flow

RESULTS AND DISCUSSION

Results

Identification of Ethnomathematical Contexts in the Meda Mazi Tradition

The literature-based analysis identified several mathematical activities that could be conceptually associated with the Meda Mazi cultural tradition of the Ngada community in East Nusa Tenggara, Indonesia. The identified contexts included the organization of participants, distribution of communal resources, estimation of logistical requirements, and allocation of time during collective deliberation activities. These activities were interpreted as potential sources of contextual mathematical problems because they involve quantitative relationships, numerical calculations, and practical decision-making. The synthesis further indicated that familiar everyday situations could provide meaningful contexts for constructing mathematical assessment tasks that connect formal mathematical concepts with students' sociocultural experiences. In this study, the mathematical potential of Meda Mazi was categorized into four principal domains: participant organization, resource distribution, logistical planning, and time management.

Participant organization was associated with counting, multiplication, division, and numerical grouping, particularly when determining the number of groups that could be formed from a specified number of participants. Resource distribution was linked to arithmetic operations, fractions, and proportional reasoning because communal activities may require equitable allocation of food or other available resources. Logistical planning provided opportunities to formulate mathematical problems involving estimation, multiplication, comparison of quantities, and resource sufficiency. Meanwhile, time management was associated with measurement, division, and proportional allocation when determining appropriate speaking durations or organizing activity schedules. These identified relationships formed the contextual foundation for developing the proposed ethnomathematics-based numeracy assessment model. However, the associations represent conceptual interpretations derived from the literature rather than mathematical practices independently verified through direct observation of Meda Mazi activities.

Table 1. Conceptual Mapping of Meda Mazi Cultural Contexts and Numeracy Competencies

Cultural context	Illustrative activity	Mathematical concepts	Target numeracy competencies
Participant organization	Dividing participants into discussion groups	Counting, multiplication, division	Numerical operations and quantitative reasoning

Resource distribution	Allocating food or other communal resources	Division, fractions, proportional relationships	Mathematical application and proportional reasoning
Logistical planning	Estimating supplies required for participants	Multiplication, estimation, comparison	Quantitative estimation and problem-solving
Time management	Distributing speaking time among participants	Time measurement, division, proportional allocation	Measurement and contextual interpretation

Development of the Three-Level Adaptive Numeracy Assessment Structure

Based on the thematic synthesis, the proposed assessment model was organized into three progressive difficulty levels: basic, intermediate, and advanced. This structure was designed to accommodate differences in students' mathematical understanding while maintaining a consistent cultural context across assessment tasks. Each level was differentiated according to the complexity of the mathematical operations, the amount of contextual information requiring interpretation, and the reasoning processes expected from students. The basic level emphasized fundamental arithmetic operations involving familiar and relatively straightforward situations associated with Meda Mazi activities. The intermediate level introduced contextual interpretation, mathematical application, and the organization of quantitative information. The advanced level incorporated multistep problem-solving, mathematical reasoning, and decision-making based on available numerical information.

At the basic level, assessment tasks were designed to evaluate students' ability to perform simple calculations involving the number of participants or the distribution of resources. For example, students could be asked to determine the number of discussion groups formed when a specified number of participants is divided equally. At the intermediate level, assessment tasks required students to interpret contextual information and apply mathematical procedures to practical situations. An illustrative task involved calculating the amount of speaking time available to each participant when a fixed discussion duration was distributed equally. At the advanced level, students were expected to analyze multiple pieces of information, establish mathematical relationships, and justify decisions. An illustrative problem involved evaluating whether the available logistical resources would be sufficient for a specified number of participants throughout a Meda Mazi activity.

The three-level structure was intended to provide progressive mathematical challenges without changing the underlying cultural context. Consequently, differences in task difficulty were primarily determined by the mathematical reasoning required rather than by the introduction of unfamiliar cultural situations. This arrangement established a conceptual basis for integrating differentiated mathematical assessment with ethnomathematical contexts.

Table 2. Proposed Difficulty Levels and Illustrative Numeracy Assessment Tasks

Assessment level	Mathematical focus	Illustrative assessment task	Expected competency
Basic	Fundamental arithmetic operations	During a Meda Mazi activity, 24 participants are divided equally into 6 discussion groups. How many participants are in each group?	Applying division to determine equal group sizes
Intermediate	Contextual interpretation and time measurement	A discussion session lasts 120 minutes. If 8 participants receive equal speaking opportunities, how many minutes are available to each participant?	Interpreting contextual information and calculating equal time allocation

Advanced	Multistep problem-solving and decision-making	A Meda Mazi activity involves 48 participants. Each participant requires 2 meal portions, while only 80 portions are available. Determine whether the available food is sufficient and calculate the additional portions required.	Analyzing resource sufficiency and justifying a quantitative decision

Conceptual Mechanism of Adaptive Assessment and Scaffolding

The proposed adaptive mechanism was formulated to adjust the difficulty of subsequent assessment tasks according to students' demonstrated mathematical understanding. Unlike a conventional assessment sequence in which all students receive identical problems, the proposed model incorporates response-based decisions to determine whether students should progress toward more complex tasks or receive additional conceptual support. The mechanism consists of three interconnected components: initial task administration, response interpretation, and adaptive task selection. Students may begin with a basic-level assessment task designed to evaluate fundamental mathematical understanding within a Meda Mazi context. Their responses are then examined to determine whether they demonstrate sufficient understanding of the targeted mathematical competency.

When students provide correct responses that satisfy the intended assessment criteria, they may proceed to tasks requiring more advanced mathematical reasoning. Conversely, when students demonstrate difficulties, the model provides opportunities to complete simpler supporting tasks before attempting more complex problems. These supporting tasks function as scaffolding activities intended to clarify mathematical relationships, reduce unnecessary complexity, and support conceptual understanding. For example, students who experience difficulties calculating equal speaking-time allocation may first complete a simpler division task involving fewer participants and a shorter discussion duration. After completing the supporting task, students may return to a problem addressing the original competency at an appropriate difficulty level.

The proposed mechanism therefore emphasizes differentiated task progression rather than a fixed assessment sequence. However, the model does not yet specify empirically calibrated difficulty parameters, validated progression thresholds, or standardized scoring rules. These components require further development before the framework can function as an operational adaptive assessment instrument.

Table 3. Proposed Adaptive Assessment and Scaffolding Mechanism

Assessment stage	Student response	Proposed adaptive action	Intended assessment function
Initial assessment	Student completes a basic-level task	Evaluate the response against the targeted competency	Identify initial mathematical understanding
Progression	Response meets the intended competency criteria	Present a task at the next difficulty level	Assess more advanced mathematical competencies
Additional support	Response indicates conceptual difficulty	Provide a simpler supporting task or scaffolding	Support interpretation of the targeted mathematical concept
Reassessment	Student completes the supporting task	Present an appropriate follow-up task	Re-examine understanding of the targeted competency
Continued assessment	Student demonstrates sufficient understanding	Continue toward a more complex task	Extend assessment of mathematical reasoning

Integration of Numeracy Competencies and Pancasila Student Profile Dimensions

The conceptual synthesis also identified potential connections between the proposed numeracy assessment model and the educational values represented in the Pancasila Student Profile. These connections emerged from the communal characteristics associated with Meda Mazi, particularly cooperation, collective responsibility, deliberation, and culturally situated decision-making. The assessment contexts were designed to incorporate situations requiring students to interpret numerical information while considering practical problems related to communal activities. For instance, resource distribution tasks provided opportunities to apply mathematical reasoning to situations involving equitable allocation, whereas logistical planning tasks required students to evaluate quantitative alternatives and formulate decisions.

The proposed framework was conceptually aligned with the six dimensions of the Pancasila Student Profile: faith and devotion to God Almighty and noble character, global diversity, mutual cooperation, independence, critical reasoning, and creativity. Mathematical problem-solving activities were most directly connected to critical reasoning and creativity because students were expected to analyze quantitative information and formulate appropriate solutions. Individual completion of differentiated assessment tasks was associated with independence, while the communal contexts represented in Meda Mazi offered opportunities to discuss mutual cooperation and collective responsibility. The use of indigenous cultural practices also provided a contextual connection to cultural appreciation and diversity. Connections with faith, devotion, and noble character were interpreted more broadly through ethical considerations and communal responsibility rather than through direct mathematical measurement.

Importantly, these relationships represent proposed educational alignments rather than empirically demonstrated improvements in students' character development. The model was designed primarily to assess numeracy competencies, while the Pancasila Student Profile dimensions functioned as complementary considerations in contextual task development. Consequently, the proposed framework should not be interpreted as a validated instrument for measuring all six character dimensions.

Table 4. Conceptual Alignment Between Assessment Activities and Pancasila Student Profile Dimensions

Pancasila Student Profile dimension	Proposed contextual connection	Illustrative assessment relevance
Faith, devotion, and noble character	Ethical responsibility in communal resource use	Considering fairness and responsibility in resource-allocation scenarios
Global diversity	Appreciation of indigenous cultural traditions	Recognizing Meda Mazi as a culturally situated context for mathematical activities
Mutual cooperation	Collective organization and shared responsibilities	Solving mathematical problems involving group organization and communal resources
Independence	Individual mathematical reasoning and task completion	Completing differentiated assessment tasks independently
Critical reasoning	Quantitative analysis and evidence-based decisions	Evaluating logistical sufficiency and interpreting mathematical information
Creativity	Exploration of alternative mathematical strategies	Developing different approaches to contextual problem-solving

Synthesis of the Proposed Ethnomathematics-Based Adaptive Numeracy Assessment Model

The integration of the identified cultural contexts, numeracy competencies, differentiated difficulty levels, and response-based progression mechanisms resulted in a conceptual ethnomathematics-based adaptive numeracy assessment framework. The framework consists of four interconnected components: Meda Mazi cultural contexts, elementary numeracy competency indicators, three progressive assessment difficulty levels, and an adaptive task-selection mechanism

incorporating scaffolding. Cultural contexts provide the situational foundation for constructing mathematical problems, while competency indicators determine the mathematical knowledge and reasoning processes targeted by each task. The three difficulty levels organize assessment tasks according to their intended cognitive complexity, and the adaptive mechanism establishes a proposed procedure for selecting subsequent tasks based on students' responses.

The resulting framework illustrates how indigenous cultural contexts may be incorporated into a differentiated numeracy assessment structure without requiring an exclusively technology-based assessment system. Its principal conceptual contribution lies in organizing ethnomathematical contexts and adaptive assessment principles within a single assessment design. Nevertheless, the framework remains at the conceptual development stage because its assessment items, difficulty classifications, progression rules, and cultural representations have not undergone expert validation or empirical testing. Accordingly, the findings establish the proposed model's structure and intended operation but do not demonstrate its validity, practicality, reliability, or effectiveness in improving students' numeracy competencies. Further research is required to translate the conceptual framework into operational assessment instruments and evaluate their implementation in elementary mathematics classrooms.

Discussion

The findings of this study suggest that integrating the Meda Mazi cultural tradition into numeracy assessment provides a promising conceptual approach to connecting elementary mathematics education with students' sociocultural experiences. The identification of mathematical activities involving participant organization, resource distribution, logistical planning, and time management illustrates how culturally situated practices can be transformed into meaningful contexts for assessing numerical reasoning and mathematical problem-solving. Contemporary ethnomathematics research emphasizes that mathematical concepts can be explored through cultural activities, traditional knowledge, and everyday community practices, thereby establishing connections between formal mathematical understanding and students' lived experiences (Mumu et al., 2026; Wildaniati et al., 2026). Musliana et al. (2024) similarly examined the mathematical potential of the historical Taman Mayura building as a contextual resource for developing elementary students' numeracy competencies. Likewise, Natih et al. (2024) investigated numeracy problems incorporating Balinese cultural contexts, highlighting the relevance of culturally familiar situations in mathematical assessment. Compared with these investigations, the present study extends the application of ethnomathematics by proposing the systematic integration of indigenous cultural contexts into a differentiated assessment framework rather than focusing exclusively on contextual mathematical activities. The proposed Meda Mazi-based assessment tasks provide opportunities to represent mathematical concepts through situations involving collective decision-making, equitable resource allocation, and quantitative planning. Nevertheless, the educational potential identified in this study should be interpreted as a theoretically informed possibility rather than empirical evidence that the proposed assessment improves students' mathematical understanding. Furthermore, the cultural authenticity of the selected activities requires verification through engagement with knowledgeable members of the Ngada community to ensure that the assessment contexts accurately represent the Meda Mazi tradition. Accordingly, the principal contribution of this finding lies in establishing a conceptual pathway for transforming culturally situated activities into structured numeracy assessment contexts while recognizing the importance of subsequent cultural and educational validation.

The proposed three-level assessment structure offers a conceptual mechanism for accommodating differences in elementary students' mathematical understanding through progressively differentiated assessment tasks. By organizing mathematical problems into basic,

intermediate, and advanced levels, the model distinguishes fundamental numerical operations from contextual interpretation and more complex mathematical reasoning. This structure is consistent with contemporary adaptive assessment principles, which emphasize adjusting assessment difficulty according to students' demonstrated competencies rather than administering identical assessment sequences to all learners (Alfageh et al., 2024; Zhang et al., 2025). Alfageh et al. (2024) investigated elementary teachers' use of adaptive diagnostic assessment to support mathematics teaching and learning, highlighting the potential relevance of assessment information for instructional decision-making. Similarly, Bang et al. (2023) examined adaptive game-based mathematics learning, while Zhang et al. (2025) explored a computerized adaptive assessment system incorporating cognitive diagnosis to support personalized mathematical learning. In comparison with these technology-oriented approaches, the present model proposes a conceptually simpler mechanism involving predefined difficulty levels, response-based task progression, and additional supporting activities. This distinction may be particularly relevant to elementary educational environments where access to sophisticated digital assessment technologies is limited, although the feasibility of implementation remains to be established. The incorporation of scaffolding reflects contemporary perspectives on differentiated mathematics instruction, which emphasize providing appropriate assistance and progressively challenging tasks according to students' learning needs. Nevertheless, organizing assessment items into three difficulty levels does not automatically establish psychometric adaptivity because operational implementation requires validated task classifications, explicit progression criteria, and evidence that assessment decisions accurately represent students' mathematical competencies. Therefore, the proposed framework provides an initial design for culturally contextualized adaptive numeracy assessment while requiring further methodological refinement to establish reliable and educationally appropriate adaptive decision-making.

The integration of Meda Mazi cultural contexts with adaptive assessment principles also contributes to contemporary discussions concerning culturally responsive and inclusive mathematics assessment. Culturally responsive assessment acknowledges that students' mathematical performance may be influenced by the cultural familiarity, linguistic accessibility, and contextual characteristics of assessment tasks (Bahar & Maker, 2020; Bennett, 2023). Shanmugam et al. (2025) examined culturally inclusive mathematics test development for Indigenous pupils, providing a relevant comparison for assessment frameworks that explicitly consider learners' cultural backgrounds. Similarly, Ntumi et al. (2026) investigated culturally responsive assessment in mathematical word problems and numerical cognition within multilingual educational contexts, emphasizing the importance of sociocultural considerations in mathematical assessment design. While these investigations emphasize cultural responsiveness in assessment development, the present study introduces an additional conceptual dimension by incorporating response-based task progression into mathematical problems derived from a specific Indonesian cultural tradition. This integration is particularly relevant because the proposed assessment tasks maintain a consistent cultural context while varying mathematical operations, information-processing demands, and reasoning complexity across difficulty levels. Such an arrangement may help distinguish differences in mathematical understanding from difficulties associated with unfamiliar problem situations, although this assumption requires empirical verification. Nevertheless, culturally contextualized assessment should not be assumed to benefit all learners equally, particularly students who have limited familiarity with Meda Mazi or originate from different cultural communities. Consequently, assessment developers must consider cultural representation, linguistic accessibility, curriculum alignment, and potential sources of construct-irrelevant difficulty when transforming indigenous practices into mathematical assessment instruments. These considerations indicate that the proposed model should be evaluated not only for mathematical validity and adaptive functionality

but also for cultural appropriateness, accessibility, and fairness across diverse elementary student populations.

Beyond its mathematical assessment orientation, the proposed framework establishes conceptual connections between Meda Mazi cultural practices and the six dimensions of the Pancasila Student Profile. The integration of local cultural contexts is consistent with Indonesian educational policies emphasizing the development of learners who demonstrate noble character, appreciation of diversity, mutual cooperation, independence, critical reasoning, and creativity (Kemendikbudristek, 2022). Within the proposed assessment model, mathematical problems involving communal resource distribution and participant organization provide opportunities to introduce situations associated with cooperation, fairness, and collective responsibility. Assessment tasks requiring students to analyze logistical requirements, interpret quantitative information, and justify mathematical solutions are more directly associated with critical reasoning and contextual problem-solving. Similarly, differentiated assessment tasks may encourage independent engagement with mathematical challenges, while open-ended problems provide opportunities for students to explore alternative solution strategies. Incorporating Meda Mazi as an assessment context also creates opportunities to introduce indigenous knowledge and encourage appreciation of local cultural traditions as part of Indonesia's cultural diversity. However, the relationship between culturally contextualized assessment activities and character development should be interpreted cautiously because exposure to culturally meaningful mathematical problems does not necessarily produce measurable improvements in students' attitudes or behavior. Unlike empirical investigations that directly evaluate educational interventions through classroom observations or validated outcome measures, the present study establishes only conceptual relationships between the proposed assessment contexts and the Pancasila Student Profile dimensions. Accordingly, the framework should primarily be regarded as a numeracy assessment design with complementary character-education relevance rather than an instrument that independently measures or strengthens all six dimensions. Future investigations should therefore distinguish mathematical competency outcomes from character-related outcomes and employ appropriate assessment instruments to evaluate the broader educational implications of the proposed model.

The overall synthesis indicates that the principal contribution of this study is the formulation of a conceptual assessment framework integrating ethnomathematical contexts, differentiated task complexity, response-based progression, and culturally responsive educational principles. Compared with previous ethnomathematics investigations emphasizing culturally contextualized mathematics learning (Musliana et al., 2024; Natih et al., 2024), the present study directs attention toward organizing cultural activities into progressively differentiated numeracy assessment tasks. In relation to adaptive mathematics assessment research (Bang et al., 2023; Alfageh et al., 2024; Zhang et al., 2025), its distinguishing characteristic is the proposed integration of indigenous cultural contexts into a non-digital, response-based assessment structure. Nevertheless, these comparisons establish a conceptual distinction rather than demonstrating that the proposed model is more effective, inclusive, or practical than existing assessment approaches. A principal limitation arises from the literature-based research design, which does not provide direct observational evidence concerning the mathematical characteristics of Meda Mazi practices or empirical information about students' responses to the proposed tasks. Furthermore, the proposed assessment items have not undergone expert judgment, content validity analysis, cognitive interviewing, difficulty calibration, reliability testing, or classroom-based feasibility evaluation. The adaptive mechanism also requires explicit operational rules defining competency achievement, progression thresholds, scaffolding procedures, and response interpretation across different difficulty levels. Subsequent research should therefore involve mathematics education specialists, assessment experts, elementary school teachers, and Ngada cultural representatives to verify cultural representations and evaluate the

conceptual and content validity of the proposed framework. Following expert validation, pilot studies and classroom investigations involving diverse elementary student populations are needed to examine task comprehension, response patterns, assessment fairness, practical implementation, and potential effects on numeracy performance. Ultimately, the proposed Meda Mazi-based adaptive numeracy assessment model offers a theoretically grounded foundation for developing culturally responsive mathematics assessment, while its educational value and practical applicability remain contingent upon rigorous empirical validation.

Implications

The findings of this study provide theoretical and practical implications for developing culturally responsive numeracy assessment in elementary mathematics education. The proposed framework integrates ethnomathematics and adaptive assessment principles by incorporating the Meda Mazi cultural tradition into differentiated mathematical tasks. This approach offers opportunities to connect mathematical competencies with culturally meaningful activities involving numerical operations, measurement, and problem-solving. The three-level assessment structure provides a conceptual basis for accommodating students' mathematical abilities through progressive task difficulty and appropriate scaffolding. For teachers, the model may serve as an alternative framework for designing contextual assessments that respond to individual learning needs. For curriculum developers, it offers a reference for integrating indigenous knowledge into mathematics assessment while supporting relevant dimensions of the Pancasila Student Profile. However, these implications remain conceptual because the model has not undergone empirical validation. Therefore, further research is required to establish its validity, practicality, and effectiveness in elementary mathematics classrooms.

Limitations and Suggestions for Future Research

This study has several limitations arising from its literature-based qualitative design, which does not provide empirical evidence regarding the effectiveness of the proposed ethnomathematics-based adaptive numeracy assessment model. The mathematical contexts associated with the Meda Mazi tradition were identified conceptually without direct cultural observation or verification by local community representatives. Furthermore, the proposed assessment tasks and three-level adaptive mechanism have not undergone expert validation, psychometric evaluation, or classroom implementation. Consequently, their validity, reliability, practicality, and effectiveness remain undetermined. Future research should involve mathematics education experts, elementary school teachers, and Ngada cultural representatives to ensure mathematical accuracy and cultural authenticity. Subsequent studies should conduct pilot testing and classroom-based evaluations to examine assessment difficulty, adaptive progression, and scaffolding effectiveness. Comparative studies are also recommended to investigate the model's potential contribution to students' numeracy competencies and its applicability across diverse educational contexts.

CONCLUSION

This study proposes an ethnomathematics-based adaptive numeracy assessment model integrating the Meda Mazi cultural tradition of the Ngada community as a contextual framework for elementary mathematics education. The literature-based analysis identified potential mathematical applications within culturally situated activities, including participant organization, communal resource distribution, logistical planning, and time management. These activities provide meaningful contexts for developing numeracy assessment tasks involving arithmetic operations, measurement, estimation, proportional reasoning, and mathematical problem-solving. The proposed model

incorporates three progressive difficulty levels, namely basic, intermediate, and advanced, to accommodate variations in students' mathematical understanding and reasoning abilities. Its adaptive mechanism is designed to adjust task complexity according to students' responses while providing additional scaffolding when conceptual difficulties arise. This approach offers a potential alternative to conventional assessment practices by combining culturally familiar mathematical situations with differentiated assessment procedures. Furthermore, integrating Meda Mazi into numeracy assessment establishes conceptual connections between mathematical competencies, indigenous cultural knowledge, and the educational values represented in the Pancasila Student Profile. The proposed framework may encourage culturally meaningful mathematical engagement while introducing contexts associated with cooperation, independence, critical reasoning, creativity, and appreciation of local traditions. The principal contribution of this study lies in integrating ethnomathematical perspectives and adaptive assessment principles into a coherent conceptual model for culturally responsive elementary mathematics assessment. Nevertheless, the model remains at the conceptual development stage, and its cultural authenticity, validity, reliability, practicality, and educational effectiveness have not been empirically established. Future research should involve mathematics education experts, elementary school teachers, Ngada cultural representatives, and students to conduct cultural verification, instrument validation, and classroom-based evaluation. Overall, the proposed Meda Mazi-based adaptive numeracy assessment model provides a theoretical foundation for developing more contextualized, inclusive, and potentially responsive assessment practices in elementary mathematics education.

AUTHOR CONTRIBUTIONS STATEMENT

Wilibaldus Bhoke contributed to the conceptualization, research design, methodology development, literature review, ethnomathematical exploration of the Meda Mazi cultural tradition, development of the adaptive numeracy assessment framework, and preparation of the original manuscript. Melkior Wewe contributed to the development of the theoretical framework, literature analysis, mathematical competency mapping, formulation of adaptive assessment mechanisms, interpretation of findings, and critical review of the manuscript. Maria Elisabet Lewar contributed to the literature investigation, identification of culturally contextualized numeracy assessment activities, thematic analysis, integration of the Pancasila Student Profile dimensions, and refinement of the conceptual model. Maria Editha Bela contributed to the literature synthesis, evaluation of culturally responsive assessment principles, interpretation of educational implications, manuscript editing, and critical revision of the intellectual content. All authors contributed to the development of the study, reviewed and approved the final manuscript, and agreed to be accountable for the accuracy and integrity of the published work.

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