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Reimagining Mathematics Education through Context and Culture: Emerging Opportunities and Pedagogical Challenges

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Abstract: Palawan, Philippines, is characterized by deep cultural heterogeneity and multilingual classrooms, making it a critical context for examining culturally responsive and localized approaches to mathematics education. Anchored on the principles of Culturally Responsive Pedagogy, Ethnomathematics, and Social Constructivism, this study investigated the opportunities and challenges of contextualizing and localizing mathematics instruction and examined its implications for teaching practices, student learning, and curriculum development in this culturally complex frontier region. Employing a sequential explanatory mixed-methods design, quantitative data were first collected through structured surveys from 100 secondary mathematics teachers and 300 students to identify general trends in perceptions of localized instruction. These findings then guided the qualitative phase, which involved semi-structured interviews and focus group discussions to explain and deepen understanding of the quantitative results. Findings revealed that contextualized and localized mathematics instruction significantly enhanced student engagement, motivation, conceptual understanding, collaboration, and cultural identity, as lessons grounded in community experiences and familiar practices made abstract concepts more meaningful and accessible. However, several systemic challenges were also identified, including limited availability of high-quality localized instructional materials, increased teacher preparation demands, linguistic diversity within single classrooms, misalignment with standardized curriculum and assessment systems, and inconsistent institutional support. This study contributes new empirical evidence on the tension between linguistic plurality and standardized educational structures within Indigenous–migrant learning environments, a dimension that remains underexamined in Southeast Asian mathematics education research. Sustainable implementation requires targeted teacher training for multi-ethnic classrooms, alignment of localized instruction with curriculum and assessment systems, adequate instructional resources, and stronger institutional and community support.

Keywords: Context-Based Learning; Contextualized Assessment; Culturally Responsive Pedagogy; Inclusive Education; Localization; Pedagogical Implications

1. Introduction

Mathematics is universally regarded as the “language of science,” yet its teaching and learning are often influenced by cultural, linguistic, and contextual realities [1]. In recent years, mathematics instruction has undergone a noticeable transformation, shifting away from traditional rote learning toward more student-centered and inquiry-based pedagogies [2]. These approaches emphasize problem-solving, critical thinking, and collaboration, aiming to cultivate students’ mathematical reasoning skills rather than focusing solely on procedural fluency or solving

equations [3,4]. Empirical evidence suggests that such methods can enhance student engagement and improve learning outcomes in mathematics [5]. Nevertheless, the effectiveness of these approaches is not universal and may vary across educational contexts. Factors such as cultural orientations, the quality of teacher preparation, and the availability of instructional resources significantly influence how mathematics teaching and learning are enacted in different settings [6].

Localization and contextualization in mathematics education have gained momentum globally and locally as strategies that render mathematics more meaningful and accessible. While mathematics is often portrayed as universal and abstract, its teaching and learning thrive when grounded in students' cultural and linguistic contexts [7]. This aligns with a study that echoed that challenges in teaching mathematics have intensified due to the tension between the analysis of mathematical lessons and learners' real-life experiences, as well as the limited opportunities for meaningful engagement beyond highly abstract instruction [8]. Hence, to ensure effective lesson delivery, educators may anchor instruction in the learners' lived experiences, using these as entry points that foster relevance and cultivate a stronger sense of belonging within the classroom.

Globally, there has been a growing shift toward localization and contextualization of mathematics instruction, where lessons are grounded in learners' everyday experiences and cultural practices to make the subject more meaningful. Recent international studies on ethnomathematics and culturally responsive pedagogy affirm that mathematics teaching is most effective when it connects to students' identities and communities. A recent study highlighted the value of integrating Indigenous and traditional knowledge into formal mathematics [9]. In the United States, classroom studies demonstrate that culturally responsive mathematical modeling (CRMM) can counter marginalization, deepen sense-making, and broaden participation in elementary mathematics [10,11]. In Southeast Asia, studies of Realistic Mathematics Education (RME) and related contextual approaches report positive teacher uptake and student responsiveness when problems are tethered to local culture, practices, artifacts, and community issues [12,13]. These findings illustrate a broader global movement to decolonize mathematics education and strengthen its relevance beyond abstract universality.

In the Philippines, policy has explicitly encouraged the localization and contextualization of instruction—particularly for Indigenous communities—through the Department of Education's Indigenous Peoples Education Curriculum Framework, which urges schools to integrate Indigenous Knowledge Systems and Practices and adapt K-12 content to local cultural and social contexts [14]. These approaches seek to make mathematics instruction more meaningful by adapting concepts, problems, and applications to learners' immediate environment, culture, and real-life experiences. Rather than treating mathematics as an abstract and detached discipline, localization and contextualization allow students to see its relevance in their daily lives, thus enhancing motivation, comprehension, and retention [14]. Recent empirical studies highlight the significant learning gains that emerge when mathematics instruction is anchored in students' experiences, native languages, and community-based practices [15-17]. By situating mathematical concepts within familiar cultural and linguistic contexts, these studies demonstrate how contextualization and localization can transform mathematics from an abstract subject into a meaningful and relevant discipline that resonates with learners' identities and everyday realities.

Palawan, known as the "last ecological frontier" of the Philippines, is also home to a rich tapestry of cultural diversity. It is a mosaic of cultural and linguistic heritage, inhabited by Indigenous communities such as the Tagbanwa, Palawano, Batak, Molbog, and others [18]. This cultural heterogeneity presents both challenges and opportunities in mathematics education. Localizing and making mathematics instruction culturally responsive is highly relevant in this context, as it allows learners to see the subject reflected in their own languages, practices, and everyday realities [19]. In such a context, mathematics education that is localized and culturally responsive can bridge the gap between abstract concepts and learners' real-life experiences. Research in Southern Palawan indicates that the use of the mother tongue in instruction, particularly for Indigenous learners, has a significant influence on academic performance in mathematics and other core subjects [20]. Teacher narratives also highlight both the opportunities and the challenges of implementing Mother Tongue-Based Multilingual Education (MTB-MLE). On one hand, educators report that instruction in the local language enhances student engagement and participation. On the other hand, they point to persistent barriers such as the scarcity of instructional resources and the difficulty of managing multiple languages in the classroom [21]. These findings suggest that leveraging students' native languages and cultural frameworks in math teaching not only fosters comprehension and belonging but also aligns with inclusive educational frameworks critical to Palawan's socio-cultural landscape.

While studies in rural and Indigenous communities in other regions similarly report improved engagement when mother tongue and cultural references are used, Palawan presents a distinct instructional challenge due to the coexistence of multiple Indigenous languages and migrant dialects within a single classroom. Unlike settings where one dominant local language is used for instruction, teachers in Palawan often manage linguistically heterogeneous classes, making it impractical to contextualize lessons in every learner's dialect and intensifying reliance on Filipino or English for assessment and curriculum alignment.

This study contributes novel insights by examining how culturally responsive and localized mathematics instruction operates within Palawan's uniquely multilingual and multicultural classrooms, a context underexplored in Southeast Asian education research. While the findings align with prior studies showing that mother tongue-based and culturally grounded instruction enhances engagement and comprehension, Palawan diverges from these contexts due to the coexistence of multiple Indigenous languages within single classrooms, intensifying challenges in lesson contextualization and curriculum alignment. Methodologically, the deliberate use of quantitative survey results to guide qualitative interview and focus group protocols provides a nuanced, sequential explanatory approach that captures both systemic constraints and pedagogical strategies in linguistically heterogeneous learning environments.

Despite these goals in making culturally responsive teaching, many teachers and schools face challenges in operationalizing localized and contextualized mathematics instruction [22]. Teachers may struggle with limited resources, inadequate training, and the difficulty of balancing global standards with local content. Recent studies show that teachers often struggle to design high-quality contextualized tasks because they lack time, curricular guidance, and a repository of validated local materials; consequently, many rely on textbook examples that fail to connect with students' experiences [23,24]. Moreover, contextualizing lessons in diverse cultural and socio-economic settings raises issues of inclusivity and equity, as what is relevant in one community may not resonate with another. Conversely, successful localization and contextualization offer opportunities for curriculum innovation, teacher creativity, and stronger connections between school and community [25]. Studies suggest that when mathematics instruction is anchored in students' realities, learners are more engaged and can develop higher-order thinking skills [26,27]. Interestingly, studies also highlighted how embedding cultural practices into mathematics tasks significantly improved Indigenous students' engagement, attitude, and performance [6,28]. Likewise, several studies found that contextualized teaching in rural schools promoted long-term retention, conceptual understanding, and active participation [29,30].

Amidst the intertwined challenges and opportunities, this study turns its lens to the localization and contextualization of mathematics education, interrogating how these approaches reshape teaching practices, influence student learning, and inform curriculum development. Rather than viewing contextualization merely as a pedagogical add-on, the inquiry positions it as a critical response to the cultural, linguistic, and social realities of learners. By engaging both the constraints that hinder its full realization and the transformative potential it carries, the study aims to generate insights that can inform educators, policymakers, and curriculum designers in reimagining mathematics education that is not only rigorous but also deeply responsive to the diverse contexts of learners.

Although localization and culturally responsive approaches in mathematics have been widely explored in broader national and international contexts, little is known about how these strategies translate within Palawan's uniquely diverse cultural and linguistic landscape. The province's blend of Indigenous communities and migrant populations presents distinct challenges and opportunities that remain underexamined in existing scholarship. This gap highlights the need for research that investigates how localized and contextualized mathematics instruction can be meaningfully adapted to Palawan's cultural heterogeneity, thereby ensuring equitable and relevant learning experiences for all learners.

Most existing studies on contextualization and culturally responsive mathematics instruction assume relatively homogeneous cultural or linguistic classroom environments. In contrast, classrooms in Palawan often consist of multiple Indigenous groups and migrant learners within a single learning space, creating conditions of deep heterogeneity. This complexity represents a critical boundary condition for the application of localization policies and pedagogical frameworks and underscores the need to examine how culturally responsive mathematics instruction operates in highly diverse and multilingual settings. Hence, this becomes the impetus for this study.

This study is grounded in three complementary theoretical perspectives: Culturally Responsive Pedagogy (CRP), Ethnomathematics, and Social Constructivism, which together provide a conceptual foundation for exam-

ining localized and contextualized mathematics instruction in culturally and linguistically diverse settings such as Palawan.

Culturally Responsive Pedagogy (CRP) emphasizes that effective instruction must connect academic content to learners' cultural identities, languages, and community experiences in order to promote engagement, motivation, and meaningful learning. In mathematics education, CRP supports the integration of students' lived experiences, cultural practices, and linguistic resources into problem-solving and classroom discourse, thereby strengthening both conceptual understanding and participation. Empirical studies demonstrate that culturally responsive mathematical practices can counter marginalization, enhance sense-making, and broaden student participation, particularly among learners from Indigenous and minoritized communities [10–12].

Complementing CRP, Ethnomathematics recognizes that mathematical knowledge is embedded in cultural activities, social practices, and traditional ways of knowing. This perspective challenges the view of mathematics as culturally neutral and highlights the educational value of Indigenous knowledge systems, community-based problem-solving strategies, and culturally situated mathematical representations. Integrating ethnomathematical elements—such as local measurement practices, patterns, counting systems, and livelihood-based applications—can serve as meaningful entry points to formal mathematical concepts and promote cultural validation in the classroom [7,9,13,25]. Studies in the Philippine context further show that embedding Indigenous practices into mathematics tasks enhances students' engagement, attitudes, and academic performance [6,19].

Meanwhile, Social Constructivism frames learning as an active and socially mediated process in which learners construct understanding through interaction, collaboration, and engagement with meaningful tasks. From this perspective, mathematical knowledge is developed through dialogue, peer collaboration, and reflective engagement with real-world problems rather than through passive reception of procedures. Student-centered and inquiry-based pedagogies that emphasize problem-solving, discussion, and shared meaning-making are therefore essential for developing deep conceptual understanding in mathematics [2,3,5]. Contextualized and localized activities function as cognitive tools that situate abstract concepts within familiar social and cultural environments, allowing learners to construct understanding based on prior knowledge and collective sense-making.

These theoretical perspectives support the shift from rote, textbook-driven instruction toward culturally grounded, student-centered, and inquiry-oriented mathematics pedagogy. They also explain why contextualization and localization are expected to enhance engagement, conceptual understanding, collaboration, and cultural identity—outcomes that this study empirically examines within Palawan's multilingual and multicultural classrooms.

These three perspectives operate as an integrated framework that guides the design and interpretation of this study. Social Constructivism provides the overarching learning lens, emphasizing that mathematical understanding develops through interaction with meaningful and socially situated tasks. Ethnomathematics identifies the cultural knowledge, community practices, and local experiences that serve as the contextual content for these tasks. Culturally Responsive Pedagogy (CRP), in turn, functions as the pedagogical and ethical bridge that ensures such cultural content is used intentionally to affirm learner identity, promote inclusion, and enhance participation. Together, these perspectives frame localization not merely as a teaching strategy but as the intersection of cognitive development, cultural validation, and educational equity within multilingual and multicultural mathematics classrooms.

2. Materials and Methods

This study employed a mixed-methods research design, specifically a sequential explanatory design, which integrates quantitative and qualitative approaches to develop a comprehensive understanding of the localization and contextualization of mathematics education. In this design, quantitative data were collected and analyzed first to establish general trends and patterns regarding the perceptions of teachers and students, followed by qualitative data collection to further explain, enrich, and contextualize the quantitative findings. The study was conducted in Palawan, a province known for its rich cultural and linguistic diversity, making it a suitable context for examining culturally responsive mathematics instruction. The quantitative component utilized a structured survey to measure the perceptions of teachers and students toward localized and contextualized mathematics instruction, while the qualitative component employed interviews and focus group discussions to explore their lived experiences, insights, and challenges in greater depth. The survey employed a five-point Likert scale (5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree). Sample items for the opportunity construct included statements

such as “Localized lessons make mathematics more interesting than textbook problems,” while challenge-related items included “I lack ready-made localized instructional materials.” This research design was deemed appropriate as it allowed for the integration of numerical evidence and in-depth narratives, providing a nuanced and holistic understanding of the unique educational realities of mathematics teaching and learning in Palawan.

Following the quantitative analysis, survey results were examined to identify patterns, trends, and areas of concern. For instance, the quantitative survey revealed that the lack of ready-made localized instructional materials was the highest-rated challenge among teachers ($M = 4.62$), followed by difficulties managing multiple languages in the classroom ($M = 4.45$) and misalignment with standardized assessments ($M = 4.38$). Based on these findings, the qualitative interview and focus group guides were specifically designed to probe teachers’ strategies for creating or sourcing instructional materials, their approaches to teaching linguistically heterogeneous classrooms, and how they align lessons with curriculum and assessments. For example, because the survey identified the lack of localized materials and assessment misalignment as major concerns, participants were asked questions such as: “How do you create or source localized instructional materials?” and “How do you balance contextualized teaching with preparation for standardized national examinations?” In this way, the qualitative phase directly explored the reasons behind the quantitative trends, providing rich, context-sensitive insights that could not be captured by the survey alone.

The participants of the study consisted of secondary school mathematics teachers and students from selected public schools in Palawan. A stratified random sampling technique was employed to ensure representation across both urban and rural schools, as well as among diverse cultural and linguistic groups. From the total quantitative sample of 100 teachers and 300 students, 15 teachers and 30 students were purposively selected for the qualitative phase. Teachers were chosen based on having at least five years of teaching experience and teaching in Indigenous-dominated or linguistically diverse classrooms, while students were selected to represent the major Indigenous and migrant cultural groups present in the participating schools. This ensured that the qualitative data reflected a range of linguistic, cultural, and instructional experiences relevant to localized mathematics education in Palawan.

The selected sample size (100 teachers and 300 students) was determined based on sample ranges commonly used in regional mixed-methods education research to ensure adequate representation of diverse school contexts across Palawan while remaining feasible for follow-up qualitative investigation. The participating teachers represented multiple districts across the province and reflected diverse linguistic backgrounds, including Tagalog, Cuyunon, Palawano, and other local languages, with teaching experience ranging from early-career to more than ten years.

The survey questionnaire was researcher-developed specifically for this study, drawing on existing literature on culturally responsive pedagogy, ethnomathematics, and contextualized instruction, as well as the Department of Education’s guidelines on localized instruction. It underwent expert validation and pilot testing to ensure content validity and reliability, with a Cronbach’s alpha coefficient of 0.92, indicating high internal consistency. Content validity was established through evaluation by a panel of five experts in mathematics education and culturally responsive pedagogy, who reviewed the instrument for clarity, relevance, and alignment with the study constructs. Feedback from the panel was incorporated prior to pilot testing. Representative sample items for each construct are presented in the Results tables to illustrate how the variables were operationalized.

The second instrument consisted of semi-structured interview and focus group discussion guides designed to elicit deeper insights into teachers’ and students’ experiences, challenges, and suggestions regarding localized mathematics instruction.

Prior to data collection, permission was secured from the school authorities and informed consent was obtained from all participants. Surveys were distributed and retrieved during scheduled class hours, while interviews and focus group discussions were conducted at mutually convenient times. All qualitative sessions were audio-recorded with consent and later transcribed for analysis.

Quantitative data were analyzed using descriptive statistics, including frequency counts, percentages, mean, and standard deviation, to summarize teachers’ and students’ perceptions. In addition, independent samples t-tests were conducted to examine differences between teachers’ and students’ overall perceptions regarding the opportunities and challenges of contextualization. Pearson correlation analysis was also performed to explore relationships between perceived institutional support and teacher confidence in implementing localized instruction [31]. Qualitative data were analyzed using a six-step thematic analysis procedure: (1) transcription and familiarization, (2) initial coding,

(3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) final reporting. To enhance trustworthiness, data triangulation across surveys, interviews, and focus group discussions was conducted [32]. Member checking with a subset of participants and peer debriefing were also employed to validate the coding and thematic structure.

Ethical principles were strictly observed in the conduct of this study to ensure the protection and rights of all participants. Before data collection, approval was sought from the appropriate institutional review board, and permission was obtained from school authorities where the research was conducted. Informed consent was secured from all participants after they were fully informed about the purpose of the study, their voluntary participation, and their right to withdraw at any time without penalty. Confidentiality and anonymity were maintained by assigning codes instead of names and ensuring that data were stored securely and used solely for research purposes. The study also adhered to the ethical guidelines for research involving human participants as outlined by the University Ethics Review Committee, thereby upholding principles of respect, beneficence, and justice throughout the research process.

3. Results

This section presents an integrated analysis of quantitative and qualitative findings. The quantitative results identify overall patterns in teachers' and students' perceptions of localized and contextualized mathematics instruction, while the qualitative findings provide explanatory insights into the experiences and contextual factors underlying these trends. The two data strands offer a comprehensive understanding of the opportunities and challenges of implementing culturally responsive mathematics education in the culturally and linguistically diverse context of Palawan.

3.1. Quantitative Analysis of Teachers' and Students' Perceptions on the Opportunities and Challenges of Contextualizing and Localizing Mathematics Education

The following tables present the perceived opportunities and challenges of contextualization and localization in mathematics education as viewed by both teachers and students, based on the results of the quantitative analysis.

Table 1 presents teachers' perceptions of the opportunities brought by contextualization and localization in mathematics education. Among the indicators, the highest mean rating was obtained by the statement *"Using local examples helps students connect mathematics to real-life problems"* ($M = 4.49$, $SD = 0.17$), suggesting that teachers strongly believe contextualized lessons foster meaningful learning by linking abstract concepts with familiar experiences. This was followed closely by *"Localizing mathematics lessons increases students' interest in learning"* ($M = 4.45$, $SD = 0.26$), which highlights the motivational value of embedding lessons within students' cultural and community contexts. Taken together, these findings suggest that contextualization serves as both a cognitive and affective bridge, strengthening understanding while fostering enthusiasm for mathematics. The overall mean score of 4.36 ($SD = 0.27$) reveals a consistently positive stance among teachers, affirming that contextualized and localized approaches are not only beneficial but also essential in making mathematics more accessible, interactive, and responsive to learners' diverse cultural realities.

Table 1. Teachers' Perceptions on the Opportunities of Contextualization & Localization in Mathematics Education.

Statement	Mean Rating	Standard Deviation	Interpretation
1. Localizing mathematics lessons increases students' interest in learning.	4.45	0.26	Strongly Agree
2. Contextualized tasks improve students' conceptual understanding of mathematical ideas.	4.42	0.37	Strongly Agree
3. Using local examples helps students connect mathematics to real-life problems.	4.49	0.17	Strongly Agree
4. Incorporating learners' languages into instruction enhances comprehension.	4.26	0.21	Strongly Agree
5. Contextualized lessons promote active participation and classroom discussion.	4.38	0.28	Strongly Agree
6. Localized materials facilitate collaborative and project-based learning.	4.21	0.35	Strongly Agree
7. Teaching with cultural references strengthens students' mathematical identity and confidence.	4.37	0.23	Strongly Agree
8. Community-based contexts make assessment tasks more authentic and meaningful.	4.40	0.27	Strongly Agree
9. Co-designing lessons with community members enriches instructional content.	4.23	0.45	Strongly Agree
10. Contextualization supports differentiated instruction for diverse learners.	4.39	0.31	Strongly Agree
Overall	4.36	0.27	Strongly Agree

Note: 1.00–1.79 (strongly disagree); 1.80–2.59 (disagree); 2.60–3.39 (neutral); 3.40–4.19 (agree); 4.20–5.00 (strongly agree).

Table 2 illustrates students' perceptions of the opportunities created by contextualization and localization in mathematics education. The results reveal a strong consensus that integrating cultural and local elements into instruction enhances both comprehension and engagement. The highest ratings suggest that students find mathematics significantly more engaging and relatable when problems are presented through localized contexts, reinforcing the idea that lessons grounded in their community experiences make the subject more meaningful and interesting. This finding underscores how contextualization transforms mathematics from an abstract discipline into a relevant part of students' everyday lives, thereby strengthening motivation and sustained attention.

Table 2. Students' Perceptions on the Opportunities of Contextualization & Localization in Mathematics Education.

Statement	Mean Rating	Standard Deviation	Interpretation
1. Mathematics lessons that use local examples are easier to understand.	4.41	0.16	Strongly Agree
2. Learning math in my first language helps me follow instructions better.	4.22	0.32	Strongly Agree
3. Contextualized problems make math feel more useful in daily life.	4.40	0.26	Strongly Agree
4. Using community examples makes me more confident when answering math questions.	4.37	0.29	Strongly Agree
5. Group tasks based on local contexts help me learn from my classmates.	4.23	0.36	Strongly Agree
6. Localized lessons make math more interesting than ordinary textbook problems.	4.47	0.21	Strongly Agree
7. I remember math concepts longer when they are taught through familiar activities.	4.24	0.35	Strongly Agree
8. Connecting math to my culture makes me proud of my community.	4.36	0.31	Strongly Agree
9. Contextualized assessments reflect what I can do in real situations.	4.44	0.20	Strongly Agree
10. I prefer teachers who use examples from our neighborhood or community.	4.26	0.37	Strongly Agree
Overall	4.34	0.28	Strongly Agree

Note: 1.00–1.79 (strongly disagree); 1.80–2.59 (disagree); 2.60–3.39 (neutral); 3.40–4.19 (agree); 4.20–5.00 (strongly agree).

The second most highly rated perception highlights the value of contextualized assessments, as students affirm that such tasks more accurately mirror their real-world capabilities. This suggests that students view localized evaluation not only as fairer but also as a more authentic measure of their mathematical understanding. These results emphasize that contextualization benefits learning both by sparking student interest and by ensuring that learning outcomes reflect practical competence. Overall, the consistently high ratings, reflected in the mean score of 4.34 (SD = 0.28), demonstrate that students regard contextualization and localization as integral to effective mathematics education. These findings imply that students are not passive recipients of such practices but active advocates, perceiving them as essential strategies for making mathematics accessible, culturally relevant, and empowering.

Table 3 depicts teachers' perceptions of the challenges they encounter in implementing contextualization and localization in mathematics education. The findings indicate that the lack of ready-made, high-quality localized materials emerged as the most pressing issue, with the highest mean score of 4.62 (SD = 0.11). This suggests that while teachers recognize the value of culturally responsive pedagogy, they often struggle with inadequate instructional resources that could support its systematic and efficient delivery. Closely following this concern is the challenge of time intensiveness, as teachers strongly agree (M = 4.51, SD = 0.18) that designing contextualized tasks requires significantly more preparation compared to conventional lesson planning. This reflects the added burden placed on teachers, who must balance curriculum requirements with the creative task of adapting mathematics to local realities. The overall mean of 4.16 (SD = 0.29), further reflects a generally high level of concern across indicators. This indicates that although teachers are receptive to contextualized and localized instruction, they face multiple obstacles that could hinder full implementation. Addressing these challenges through improved resource development, targeted professional training, and stronger administrative support will be crucial to translating the opportunities of contextualization into sustained classroom practice.

Table 4 presents students' perceptions of the challenges associated with contextualization and localization in mathematics education. The results reveal that the most significant concerns relate to the lack of sufficient learning materials. Students strongly agreed that their schools often do not provide enough localized resources such as manipulatives and books (M = 4.24, SD = 0.27). Similarly, they expressed strong agreement (M = 4.22, SD = 0.23) that teachers do not always make clear connections between localized examples and exam-oriented questions. These findings suggest that while students appreciate contextualized approaches, gaps in resource provision and instructional alignment create challenges that may limit the effectiveness of localized lessons. Interestingly, they strongly disagreed (M = 1.76, SD = 0.16) that localized lessons slow down coverage of the syllabus, indicating that students do not perceive pacing as a significant issue. Meanwhile, moderate agreement was observed in areas such as teacher

confidence ($M = 3.56$, $SD = 0.35$) and the lack of grade-level appropriate localized materials ($M = 3.61$, $SD = 0.24$), suggesting areas for professional development and instructional resource enhancement. The overall mean of 2.96 ($SD = 0.27$), interpreted as “Neutral,” indicates that students generally do not view contextualization and localization as highly problematic. Instead, their challenges are specific and situational, primarily revolving around resource availability and instructional clarity. This implies that students remain open and positive toward localized mathematics instruction, provided that sufficient materials are available and teachers explicitly link localized examples to formal assessments.

Table 3. Teachers’ Perceptions on the Challenges of Contextualization & Localization in Mathematics Education.

Statement	Mean Rating	Standard Deviation	Interpretation
1. I lack ready-made, high-quality localized learning materials for mathematics.	4.62	0.11	Strongly Agree
2. Developing contextualized tasks requires more preparation time than standard lessons.	4.51	0.18	Strongly Agree
3. It is difficult to align localized lessons with the national curriculum and learning standards.	3.99	0.42	Agree
4. There is insufficient training on how to design culturally responsive mathematics tasks.	4.18	0.29	Agree
5. Managing multiple local languages in the classroom is challenging during instruction.	4.21	0.26	Strongly Agree
6. Assessing learning from localized tasks is difficult with existing examination formats.	4.28	0.29	Strongly Agree
7. Limited access to manipulatives and local resources constrains lesson implementation.	4.16	0.32	Agree
8. Classroom size and mixed-ability groups make contextualization harder to implement.	4.07	0.25	Agree
9. Administrative support for contextualized approaches is inconsistent across schools.	4.13	0.31	Agree
10. Teachers face resistance from some parents or community members to locally adapted lessons.	3.41	0.48	Agree
Overall	4.16	0.29	Agree

Note: 1.00–1.79 (strongly disagree); 1.80–2.59 (disagree); 2.60–3.39 (neutral); 3.40–4.19 (agree); 4.20–5.00 (strongly agree).

Table 4. Students’ Perceptions on the Challenges of Contextualization & Localization in Mathematics Education.

Statement	Mean Rating	Standard Deviation	Interpretation
1. Sometimes local examples are unfamiliar to me and make the lesson confusing.	1.99	0.76	Disagree
2. I find it hard to switch between my mother tongue and the language used in tests.	1.92	0.63	Disagree
3. My school does not have enough materials (manipulatives, books) for localized lessons.	4.24	0.27	Strongly Agree
4. Teachers do not always explain how localized examples relate to exam questions.	4.22	0.23	Strongly Agree
5. Different classmates use different languages, which makes group work difficult.	2.18	0.61	Disagree
6. Some localized tasks are too complex and do not help me solve typical exam items.	2.09	0.26	Disagree
7. I feel some teachers are not confident in teaching using local contexts.	3.56	0.35	Agree
8. Localized lessons sometimes move slower, leaving less time to cover the whole syllabus.	1.76	0.16	Strongly Disagree
9. I worry that what I learn in localized lessons might not be useful for national exams.	1.87	0.31	Disagree
10. There are few examples of localized math materials that match my grade level.	3.61	0.24	Agree
Overall	2.96	0.27	Neutral

Note: 1.00–1.79 (strongly disagree); 1.80–2.59 (disagree); 2.60–3.39 (neutral); 3.40–4.19 (agree); 4.20–5.00 (strongly agree).

3.2. Qualitative Analysis of Teachers’ and Students’ Perceptions on the Opportunities and Challenges of Contextualizing and Localizing Mathematics Education

The qualitative findings presented below further explain and elaborate the quantitative trends, particularly the high perceived benefits of contextualization and the key challenges related to resources, language diversity, and assessment alignment.

3.2.1. Thematic Analysis of the Opportunities of Contextualizing and Localizing Mathematics Education

The qualitative themes presented below elaborate the high opportunity ratings reported by both teachers and students in **Tables 1** and **2**. These narratives explain how contextualization enhances engagement, understanding, collaboration, and cultural identity in mathematics learning.

Theme 1: Enhanced Student Engagement and Motivation

A major theme emerging from the narratives is the increased interest and participation of students when mathematics lessons are contextualized. Teachers observed that linking lessons to students’ daily experiences captures their attention and encourages active learning. One teacher shared, “*When I use examples from the community or our daily life, students immediately become more interested and willing to participate in solving problems.*” Students echoed this sentiment, with one noting, “*Math feels more fun and easier to understand when it relates to things I*

see or do at home." These narratives suggest that contextualization transforms mathematics into a relatable and motivating subject rather than a purely abstract discipline.

Theme 2: Improved Conceptual Understanding

Another prominent theme is the enhancement of students' comprehension of mathematical concepts. Contextualized tasks allow learners to connect abstract ideas to real-life situations, which supports deeper understanding. A student remarked, *"I remember math concepts longer when we use examples from my neighborhood or culture,"* highlighting the cognitive benefits of culturally relevant instruction. Teachers also emphasized that using local contexts helps students grasp complex ideas, making mathematics more accessible and meaningful.

Theme 3: Promotion of Collaboration and Peer Learning

Contextualization was also associated with increased collaboration and peer interaction. Group activities grounded in local contexts provided students with opportunities to share perspectives and learn from one another. One teacher explained, *"When we organize projects around local examples, students naturally help each other and discuss strategies, which builds teamwork and learning."* Students reflected similar experiences, noting that working together on community-based problems helped them understand different approaches and reinforced learning through peer support.

Theme 4: Strengthening Cultural Identity and Confidence

A recurring theme was the impact of localized lessons on students' cultural pride and self-confidence. Teachers noted that integrating cultural references and community practices empowers learners to see themselves reflected in the curriculum. One teacher said, *"When students see their own culture reflected in the lesson, they feel more confident and prouder of what they know."* A student similarly shared, *"I feel proud when math shows something about my community or traditions."* These narratives indicate that culturally responsive instruction not only supports academic growth but also reinforces students' sense of identity and belonging.

Theme 5: Support for Differentiated and Inclusive Learning

Finally, contextualized instruction was recognized as a strategy that supports differentiated learning. By incorporating students' languages, prior knowledge, and lived experiences, teachers can tailor lessons to meet diverse needs. One teacher noted, *"Contextualization allows me to adjust tasks for different learners, ensuring that everyone can participate meaningfully."* This theme underscores the potential of localized approaches to make mathematics more inclusive and responsive to the diversity of students' backgrounds.

3.2.2. Thematic Analysis of the Challenges of Contextualizing and Localizing Mathematics Education

The following themes provide deeper insights into the challenges identified in **Tables 3** and **4**. The narratives clarify the contextual and systemic factors behind concerns related to resources, time demands, language diversity, teacher preparedness, and assessment alignment.

Theme 1: Insufficient Instructional Resources

A major challenge identified in the study was the lack of readily available localized instructional materials and learning resources. Teachers reported difficulty in sourcing high-quality materials that accurately reflect students' local realities, often being forced to create their own resources, which is both time-consuming and labor-intensive. One teacher shared, *"We want to use real-life examples, but there are no standard materials we can depend on. Most of the time, we have to design everything from scratch."* Students also felt the impact of this scarcity, expressing frustration over the limited availability of manipulatives and textbooks that align with localized approaches. As one student noted, *"Sometimes our teachers bring examples from our community, but we don't have enough materials like books or visuals to follow along."* These narratives highlight that while teachers and students recognize the value of contextualized instruction, the lack of adequate resources remains a significant barrier to effective implementation.

Theme 2: Time and Curriculum Constraints

Teachers emphasized that preparing contextualized lessons requires significantly more time compared to stan-

dard instruction, a challenge further compounded by the pressure to meet curriculum coverage and national standards. One teacher explained, *"It takes me hours to prepare a single contextualized lesson compared to just using what's in the textbook. And still, I have to finish all the competencies."* Students also highlighted the impact of slower-paced lessons, noting that some localized activities extend class time and create concerns about completing the syllabus or being adequately prepared for standardized exams. As one student shared, *"Localized lessons are interesting, but sometimes we run out of time to cover other topics. I worry we won't finish everything in the syllabus."* These insights underscore the tension between delivering culturally and contextually relevant instruction and fulfilling the demands of a standardized curriculum.

Theme 3: Language and Cultural Diversity

Both groups highlighted language-related issues. The use of multiple languages in multilingual classrooms emerged as a significant challenge in contextualized and localized mathematics instruction. Teachers reported difficulties in managing students who speak different dialects, noting that explaining mathematical concepts in each learner's language is often impractical. One teacher shared, *"In one class, I have students who speak different dialects. Explaining a math concept in their own languages is not always possible."* Students also highlighted the cognitive load involved in switching between their mother tongue and the language used in assessments. As one student remarked, *"I get confused when the lesson is explained in my dialect but the test is in English. It feels like I have to translate twice."* These narratives underscore that while localization aims to promote inclusivity, linguistic diversity can inadvertently create inconsistencies in comprehension and classroom participation, posing additional challenges for both teachers and learners.

Theme 4: Limited Training and Teacher Preparedness

Teachers acknowledged that they have not received sufficient professional development in designing culturally responsive mathematics tasks, which limits their ability to effectively implement localized lessons. One teacher explained, *"We are encouraged to localize, but there is no proper training on how to design activities that really fit the culture of the learners."* Some students also perceived this gap, noting that teachers sometimes appear uncertain when integrating local contexts into instruction. As one student shared, *"Sometimes our teachers are not confident when using local examples, so the lesson feels incomplete."* These narratives highlight that the lack of targeted training and support for teachers contributes to inconsistent classroom practices, suggesting that professional development is essential for the successful implementation of culturally responsive mathematics education.

Theme 5: Misalignment with Assessment Systems

A recurring challenge identified in the study was the perceived disconnect between localized instruction and standardized examinations. Teachers reported difficulty in designing assessments that accurately capture students' learning from contextualized tasks, emphasizing that national exams often do not reflect local contexts. One teacher remarked, *"The exams are standardized. Even if I localize my lessons, in the end I still have to prepare my students for a test that does not reflect local contexts."* Students also shared concerns about the relevance of localized lessons to high-stakes testing, with one noting, *"I enjoy localized activities, but sometimes I think they won't help me answer the questions in the national exams."* These statements illustrate that misalignment between contextualized instruction and standardized assessments can undermine both the perceived value and effectiveness of localization efforts in mathematics education.

Theme 6: Inconsistent Support from Stakeholders

Teachers also highlighted the challenge of insufficient institutional and administrative support, noting that the promotion of localization is not consistently prioritized across schools. One teacher explained, *"In our school, localization is more of a personal initiative. There's no consistent policy or support from administrators."* Resistance from some parents or community members further complicates implementation, as students reported experiences of skepticism regarding the value of localized lessons. One student shared, *"My parents once asked why our teacher used local games in math. They think it's not serious enough compared to regular lessons."* These suggest that inconsistent support from school authorities and community stakeholders undermines both the sustainability of localized instruction and teacher motivation, posing a systemic barrier to effective implementation.

4. Discussions

The findings of this study should be interpreted within the integrated framework of Social Constructivism, Ethnomathematics, and Culturally Responsive Pedagogy (CRP). Social Constructivism explains how contextualized tasks facilitated collaborative learning and meaningful knowledge construction through interaction and real-life problem solving. Ethnomathematics is reflected in the use of cultural practices and community experiences as cognitive entry points to abstract mathematical concepts. Meanwhile, CRP provides the pedagogical rationale for integrating learners' languages, identities, and lived experiences to enhance engagement and participation. The results confirm that the intersection of these three perspectives supports both cognitive development and cultural affirmation in multilingual mathematics classrooms.

The quantitative analysis of teachers' and students' perceptions highlights both the significant opportunities and notable challenges associated with contextualizing and localizing mathematics education. Teachers overwhelmingly perceive contextualization as a powerful strategy for making mathematics more meaningful and engaging. Lessons that integrate local examples and community experiences are seen not only as enhancing students' comprehension but also as fostering motivation and enthusiasm for learning. This aligns with international literature, which emphasizes that culturally responsive instruction can strengthen both cognitive understanding and affective engagement in mathematics [2,15]. Students' perspectives corroborate these findings, revealing that contextualized instruction transforms mathematics from an abstract subject into one that resonates with their everyday experiences, while localized assessments are perceived as fairer and more reflective of practical competence. Collectively, these results suggest that both teachers and students recognize the value of embedding mathematics within local contexts as a means of making learning more interactive, culturally relevant, and empowering. These findings are also consistent with international research conducted in multilingual contexts such as Sub-Saharan Africa and Northern Canada, where culturally responsive and mother tongue-based instruction improves student engagement but encounters challenges related to classroom linguistic diversity, resource limitations, and alignment with standardized assessment systems [26,27].

The findings of this study strongly align with the core principles of Culturally Responsive Pedagogy (CRP), Ethnomathematics, and Social Constructivism, reinforcing the theoretical assumptions that culturally grounded and socially mediated learning environments enhance mathematical understanding and engagement. Consistent with CRP, both teachers and students reported that integrating local experiences, community practices, and familiar languages into instruction increased motivation, participation, and confidence. This supports prior research demonstrating that culturally responsive mathematical practices foster inclusion, strengthen learner identity, and counter marginalization in classroom settings [10–12]. The strong student agreement that community-based examples and localized assessments reflect real-life competencies further illustrates how CRP transforms mathematics into a culturally meaningful and socially relevant discipline rather than an abstract academic requirement.

From the perspective of Ethnomathematics, the observed improvements in conceptual understanding and cultural pride reflect the educational value of integrating Indigenous and community-based knowledge systems into formal mathematics instruction. Students' narratives indicating stronger retention and comprehension when lessons are connected to cultural practices and daily activities are consistent with studies emphasizing that mathematical ideas embedded in cultural contexts serve as effective cognitive bridges to formal concepts [7,9,13,25]. Philippine-based research similarly confirms that indigenized and community-based mathematical tasks improve engagement and performance among Indigenous learners [6,19]. These findings affirm that ethnomathematical approaches not only support academic achievement but also contribute to cultural validation and identity formation, particularly in Indigenous-dominated learning environments.

The results also reflect key principles of Social Constructivism, as students emphasized the value of collaboration, peer discussion, and shared problem-solving during contextualized group tasks. Such interactions enable learners to co-construct mathematical understanding through dialogue and collective reasoning, aligning with constructivist views that knowledge emerges through social engagement and meaningful activity [2,3,5]. Contextualized tasks grounded in real-life situations provided authentic problem contexts that facilitated deeper sense-making and reflection, supporting the notion that learning is most effective when students actively construct meaning rather than passively receive procedures. These theoretical alignments explain why localized and contextualized instruction in Palawan enhances both cognitive and affective dimensions of learning, validating the combined ap-

plication of CRP, ethnomathematics, and constructivist pedagogy in culturally diverse mathematics classrooms.

Despite the clear opportunities, the analysis also highlights significant challenges that may hinder effective implementation. Teachers identify the lack of high-quality, ready-made localized materials and the additional time required to prepare contextualized lessons as primary obstacles. These findings are consistent with Cansino et al. [21] and Nicol et al. [22], indicating that resource constraints and preparation demands can limit the sustainability of culturally responsive teaching. Furthermore, aligning localized lessons with national curriculum standards remains a persistent concern, emphasizing the tension between curriculum requirements and the creative adaptation of content to local realities. Students similarly report challenges, particularly in the limited availability of instructional materials and the need for explicit connections between localized lessons and exam-oriented content. Interestingly, students do not perceive pacing as a major issue, suggesting that their engagement with contextualized instruction offsets concerns about syllabus coverage [20].

Interestingly, the quantitative findings indicate a positive perception of contextualization and localization among both teachers and students, with challenges largely centered on resources, alignment, and teacher support. These insights corroborate with Molanda et al. [16], who underscore the importance of providing adequate instructional materials, professional development, and administrative backing to ensure that the potential benefits of culturally responsive mathematics instruction can be fully realized. By addressing these challenges, schools can create an environment where localized and contextualized mathematics education not only engages learners but also fosters deeper understanding and practical competence, echoing the global and local literature advocating for culturally relevant pedagogy [8].

Conversely, the findings from the qualitative analyses illuminate the multifaceted impact of contextualizing and localizing mathematics education, revealing significant opportunities as well as persistent challenges. The narratives underscore that contextualization and localization enhance student engagement and motivation, with lessons tied to real-life and community experiences capturing learners' interest and encouraging active participation. This aligns with existing research on culturally responsive pedagogy, which emphasizes that connecting instruction to students' cultural and social contexts fosters both cognitive and affective engagement [10,15,22,24]. Furthermore, these approaches were reported to improve conceptual understanding, as students could relate abstract mathematical ideas to familiar situations, supporting deeper comprehension and retention, consistent with findings by Molanda et al. [16] and Alumia et al. [30].

Contextualized lessons also promote collaboration and peer learning, with group activities in local contexts enabling students to share perspectives and reinforce understanding through peer interaction. This resonates with research highlighting the social and cooperative benefits of culturally relevant mathematics instruction [12,13,24,29]. Additionally, localization strengthens cultural identity and confidence, as students see their own traditions, language, and community practices reflected in the curriculum, which enhances self-efficacy and pride in their learning environment [6,7]. This also aligns with Cortez [28], who posited that the capacity of these approaches to support differentiated and inclusive learning further suggests that they can effectively address the diverse linguistic and cultural backgrounds of students, aligning with DepEd's emphasis on culturally responsive instruction in the Philippine context.

Despite these opportunities, several challenges emerged. Teachers and students reported insufficient instructional resources as a major barrier, with limited access to high-quality, localized materials and manipulatives impeding lesson delivery. This echoes prior findings that resource scarcity constrains the implementation of culturally relevant pedagogy [11,12]. Time and curriculum pressures also pose challenges, as preparing contextualized lessons is more labor-intensive, and localized activities may progress more slowly than standard instruction, creating tension with coverage requirements and national examinations [9,19]. Linguistic diversity adds another layer of complexity, with teachers struggling to manage multiple local languages and students experiencing cognitive load when switching between dialects and standardized assessment language.

A critical theoretical and practical dilemma emerging from the findings is the challenge of classroom plurality. While culturally responsive pedagogy aims to connect instruction to each learner's specific cultural and linguistic background, the coexistence of multiple Indigenous groups and migrant populations within a single classroom often makes individualized cultural alignment impractical. As a result, teachers frequently adopt a generalized or "multi-local" contextualization approach, or revert to Filipino or English for instructional efficiency and assessment alignment. This tension highlights an important boundary condition for localization in hyper-diverse contexts such as Palawan and suggests the need for flexible, multi-cultural instructional strategies rather than single-culture lo-

calization models.

Limited professional development further undermines the consistent implementation of localized instruction, with teachers expressing the need for targeted training to design culturally responsive tasks effectively, which mirrors concerns raised in both local and international studies on teacher preparedness in culturally responsive mathematics education [13,21]. Further, misalignment between localized instruction and standardized assessment systems emerged as another challenge, with both teachers and students worried about the relevance of contextualized lessons for high-stakes testing. Finally, inconsistent institutional and community support was identified as a systemic barrier, with localized initiatives often depending on individual teacher effort rather than structured school policies, limiting sustainability and motivation [29–31].

The findings suggest several policy implications for the Department of Education and related stakeholders. First, the Indigenous Peoples Education Curriculum Framework should incorporate strategies for multi-local or poly-focal contextualization that support linguistically and culturally heterogeneous classrooms. Second, teacher professional development programs should include training on designing culturally responsive mathematics tasks for multi-ethnic settings and aligning localized instruction with national assessment standards. Third, the development of centralized repositories of validated, localized instructional materials would help reduce teacher workload and improve implementation consistency across schools.

5. Limitations

Several limitations should be acknowledged. First, the study relied primarily on self-reported perceptions of teachers and students, which may be influenced by social desirability bias. Second, the research did not include direct classroom observations, limiting the ability to verify the actual implementation of contextualized instructional practices. Third, although the sample represented diverse school contexts within Palawan, the findings may have limited generalizability to more homogeneous urban or non-Indigenous educational settings. Future studies may incorporate classroom observations, longitudinal designs, or experimental approaches to further examine the impact of localized mathematics instruction.

6. Conclusions

Contextualizing and localizing mathematics education in Palawan, Philippines, offers significant pedagogical benefits while also presenting notable challenges that need to be addressed for effective implementation. Both quantitative and qualitative analyses indicate that teachers and students perceive contextualized lessons as highly engaging and motivating, with real-life and community-based examples enhancing comprehension, fostering active participation, and making mathematics more meaningful and relevant. Localized instruction also supports collaboration, peer learning, cultural identity, confidence, and differentiated learning, making it a powerful strategy to address the diverse linguistic and cultural backgrounds of students.

At the same time, several challenges were identified. Teachers face a shortage of high-quality localized materials and manipulatives, increased preparation demands, and difficulty aligning contextualized lessons with national curriculum standards. Students experience difficulties when localized instruction is not adequately supported with resources or clearly linked to assessments, and the use of multiple languages in the classroom can complicate comprehension and participation. Limited professional development, misalignment with standardized assessments, and inconsistent institutional and community support further constrain the effective implementation of localized mathematics education.

Notably, the study highlights that while contextualization and localization have substantial potential to enhance student engagement, understanding, and cultural relevance, these benefits can only be fully realized with systematic support. Providing adequate instructional materials, targeted teacher training, alignment with curriculum standards and assessments, and consistent institutional and community backing are essential to ensure that localized mathematics education is not only effective but also sustainable, inclusive, and culturally affirming.

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Institutional Review Board Statement

The study was conducted in accordance with the ethical principles set forth in the Declaration of Helsinki. Ethical evaluation and approval were obtained through the institutional review process of Palawan State University, which functions as the equivalent of an Institutional Review Board. This process ensured that all ethical standards for research involving human participants—including informed consent, confidentiality, and voluntary participation—were strictly observed. Consequently, the ethical review and approval requirements were fully satisfied in accordance with the University's institutional guidelines.

Informed Consent Statement

Informed consent was obtained from all participants involved in the study. Prior to their participation, individuals were provided with clear and comprehensive information regarding the purpose of the research, the procedures to be undertaken, the expected duration of involvement, and any potential risks or benefits. Participants were also informed of their right to withdraw from the study at any time without any penalty. To ensure transparency and understanding, they were given the opportunity to ask questions and seek clarification before providing consent.

Moreover, participants were assured that all personal information would be treated with strict confidentiality and used solely for the purposes of this study. Written informed consent was secured prior to data collection, indicating that participants fully understood the research process and voluntarily agreed to participate.

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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Conflicts of Interest

The author declares no conflict of interest from any parties known to the researcher in the design of the study, in the collection and analysis of data, in the writing of the manuscript, or in the decision to publish the results.

AI Use Statement

Portions of the manuscript were edited using AI-assisted language tools to improve clarity and organization. All conceptualization, analysis, interpretation, and conclusions remain the original work of the author.

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