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IMPLEMENTATION OF A CULTURE-BASED LEARNING MODEL INTEGRATING BUGIS-MAKASSAR PHILOSOPHY IN BASIC MATHEMATICS: A QUALITATIVE EXPLORATION

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Abstrak

Pembelajaran matematika di sekolah dasar sering kali mengalami dikotomi dengan realitas budaya siswa, sehingga menyebabkan konsep abstrak sulit diinternalisasi. Penelitian ini bertujuan untuk mengeksplorasi dan mendeskripsikan implementasi inovasi pembelajaran matematika berbasis filosofi Bugis-Makassar (Model BBM) dalam menciptakan harmoni antara angka dan budaya. Melalui pendekatan kualitatif deskriptif-eksploratif, penelitian dilakukan terhadap 28 siswa kelas V SD Negeri No. 141 Pakka, Kabupaten Sinjai, pada materi jaring-jaring bangun ruang (kubus dan balok). Data dihimpun melalui observasi, wawancara, tes hasil belajar, angket sosiometri, dan respon siswa. Kebaruan penelitian ini terletak pada integrasi sistematis empat pilar filosofis (*Siri'*, *Pacce*', *Abbulosibatang*, dan *Sipakatau*) sebagai kerangka kerja pedagogis aktif, bukan sekadar etnomatematika sebagai objek materi. Temuan mengungkapkan: (1) Model BBM mentransformasi proses belajar menjadi ruang penguatan karakter; (2) Secara empiris, pemahaman materi meningkat signifikan dengan kenaikan skor rata-rata dari 23,75 menjadi 59,11; (3) Dinamika tutor sebaya berbasis *Pacce*' dan kolaborasi *Abbulosibatang* efektif memitigasi hambatan belajar siswa; (4) Inovasi ini memicu respon positif mutlak (100%) dari siswa. Dapat disimpulkan bahwa model BBM bukan sekadar alat bantu kognitif, melainkan paradigma revitalisasi identitas kultural yang berfungsi sebagai fondasi etis untuk mencapai ekselensi numerasi. Penelitian ini memberikan kontribusi teoritis pada pengembangan kurikulum berbasis kearifan lokal yang mampu menjembatani kesenjangan antara pendidikan formal dan nilai sosiokultural siswa.

Kata kunci: Pendidikan Matematika; Etnopedagogi; Filosofi Bugis-Makassar; Model Pembelajaran BBM; Pembelajaran Berbasis Karakter

Abstract

Mathematics education in elementary schools frequently encounters a dichotomy with students' cultural realities, rendering abstract concepts difficult to internalize. This study explores and describes the implementation of a mathematics learning innovation based on the Bugis-Makassar Philosophy (BBM model) to create a synergy between numerical concepts and indigenous culture. Utilizing a descriptive-exploratory qualitative approach, the research involved 28 fifth-grade students at Elementary School 141 Pakka, Sinjai Regency, focusing on the geometry of cube and cuboid nets. Data was triangulated through systematic observation, semi-structured interviews, learning achievement tests, sociometric questionnaires, and student response surveys. The novelty of this research lies in the systematic integration of four philosophical pillars—*Siri'*, *Pacce*', *Abbulosibatang*, and *Sipakatau*—as an active pedagogical framework, transcending the use of ethnomathematics as a mere instructional object. The findings reveal that: (1) The BBM Model transforms the instructional process into a space for character building and ethical development; (2) Empirically, conceptual understanding improved significantly, with average scores rising from 23.75 to 59.11; (3) The dynamics of *Pacce*'-based peer tutoring and *Abbulosibatang*-based collaboration effectively mitigated cognitive learning barriers; and (4) The innovation garnered an absolute positive response (100%) from participants. This study concludes that the BBM model serves not only as a cognitive scaffold but also as a paradigm for revitalizing cultural identity, functioning as an ethical foundation for achieving numeracy excellence. These findings provide a substantial theoretical contribution to the formulation of local wisdom-based curricula that can reconcile formal education with students' sociocultural values.

Keywords: Mathematics Education; Ethno-pedagogy; Bugis-Makassar Philosophy; BBM Learning Model; Character-based Learning

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INTRODUCTION

The low numeracy literacy of Indonesian students remains a systemic challenge in education. The Programme for International Student Assessment (PISA) data consistently shows that Indonesian students' numeracy skills have not reached a satisfactory level (Marhami et al., 2024; Thien et al., 2015). The main problem lies not only in the complexity of formulas but also in students' inability to transfer abstract concepts into real-life contexts (Hendriana et al., 2022; Russo et al., 2023). Initial observations at Public Elementary School No. 141 Pakka, Sinjai Regency, confirmed these findings: learning remains teacher-centered and uses urban-centric materials, creating the perception that mathematics is a rigid discipline irrelevant to students' social realities. Although South Sulawesi boasts an intellectual heritage steeped in traditional Bugis-Makassar architecture and philosophy, steeped in mathematical logic (Ahmad et al., 2024; Mutmainna et al., 2025), the formal education system often neglects these cultural artifacts (Wijaya Mulya et al., 2024). Cognitive dissonance occurs when students learn geometry without realizing that the structures of their stilt houses are manifestations of sophisticated geometric principles (Wahyuni et al., 2024). Furthermore, globalization threatens the sustainability of local character values such as *Sipakatau*, Sipakalebbi, and *Sipakainge*' (Wisran & Furwana, 2025; Yuliyanna et al., 2024), which are essential for maintaining cultural identity and community cohesion in South Sulawesi.

To bridge this gap between formal mathematics and student reality, a structured pedagogical transformation is required through the Culture-Based Learning (CBL) model. CBL is an instructional framework that intentionally utilizes students' cultural heritage, local wisdom, and lived experiences as a meaningful vehicle to facilitate learning (Arafah et al., 2024; Dwiputra & Sundawa, 2023; Hasibuan et al., 2024; Kharismawati & Riyana, 2025). Rather than treating culture merely as an add-on topic, the CBL model positions local values as a cognitive bridge that helps students contextualize abstract concepts, making learning more relevant and relatable (Sugiyarti et al., 2024; Tambunan, 2025). By anchoring new information within the students' existing cultural schema, this model fosters deeper engagement, enhances conceptual retention, and simultaneously reinforces character education by instilling a sense of cultural identity and pride. In the context of mathematics, a culture-based approach allows students to see the subject not as a foreign, detached discipline, but as an active tool that has long been integrated into their community's daily life and historical traditions (Prahmana, 2022; Zuliana et al., 2025).

Prior research in ethnomathematics has predominantly concentrated on the examination of physical artifacts, such as temples, batik, or handicrafts, as ancillary educational resources (Fouze & Amit, 2017; Hasibuan & Rakhmawati, 2025; Krisdiana et al., 2025; Laili et al., 2025; Mufidah et al., 2024; Munthahana & Budiarto, 2020). However, a research gap remains regarding the integration of nonphysical philosophical values into structured pedagogical methods. This study aims to fill this gap by integrating Bugis-Makassar philosophical values (*Siri'*, *Pacce*, *Sipakatau*, *Abbulosibatang*) not merely as content but as the foundation of learning methods. The theoretical framework of this research is based on the ethnomathematics paradigm, which views mathematics as a cultural product (Batiibwe, 2025; D'Ambrosio & Rosa, 2017; Prahmana, 2022). The implementation of the BBM model in this research integrates sociocultural learning theory with local values, where the principle of *Abbulosibatang* (unity) is used to optimize group dynamics, and the value of *Pacce* (solidarity) is used to contextualize the concept of sharing in fractions.

Based on these problems, this research aims to answer the following questions:

1. How is the implementation of the BBM Model, which integrates Bugis-Makassar philosophy, conducted in elementary school mathematics learning?
2. To what extent is the BBM Model effective in improving students' conceptual understanding and character at Elementary School 141 Pakka?
3. What are students' and educators' perceptions of the implementation of local values-based mathematics in reducing the stigma of learning difficulties in mathematics?

The main contribution of this research is to provide an innovative learning model (the BBM Model) that synergizes international academic standards with local wisdom. Theoretically, this research enriches the discourse on ethnomathematics by shifting the focus from mere physical artifacts to the integration of philosophical values. Practically, this research provides guidance for educators in South Sulawesi to utilize sociocultural backgrounds as catalysts for achieving meaningful numeracy literacy, which can enhance students' engagement and understanding of mathematical concepts in a culturally relevant context.

METHOD

This study uses a qualitative approach with a descriptive-exploratory design to analyze the implementation of the Bugis-Makassar (BBM) model—a specific adaptation of the broader Culture-Based Learning (CBL) framework—at Elementary School 141 Pakka, Sinjai Regency, during eight meetings in the odd semester of the 2025/2026 academic year. The study subjects involved all 28 fifth-grade students, from which one heterogeneous focus group consisting of four students (NRN, RSN, AKL, and HTK) was selected through a purposive sampling technique. The data used for this selection were the students' cumulative mathematics formative assessment scores from the previous semester, combined with teacher teacher-logged behavioral observations regarding classroom participation. To analyze and categorize these data, descriptive statistical analysis was applied to determine the mean (μ) and standard deviation (σ), establishing normative cut-off scores for grouping. The precise selection criteria for this focus group included high (score > 80), medium (score 65–79), and low (score < 65) categories based on gender balance and initial mathematics ability levels to capture the dynamics of sociocultural collaboration and the effectiveness of the learning model in depth and comprehensively.

The BBM (Bugis-Makassar) model introduced in this study is an original pedagogical model developed by the researchers. It was specifically designed by the authors to structurally transform local philosophical wisdom into actionable classroom steps, rather than adopting a pre-existing framework. To ensure replicability and clarity for future implementation, this newly developed model was operationalized through four structured syntax stages, as detailed in Table 1 below.

Table 1. BBM Model Operational Syntax

Steps	Teacher & Student Activities	Philosophical Values
Pre-instructional	The teacher presents cultural artifacts (e.g., the structure of a stilt house) as a catalyst for geometry.	*AppakaSiri'* (Motivation)
Appasituju (Value Instillation)	Heterogeneous group formation and the internalization of collaborative ethics.	*Sipakatau, Abbulosibatang*

Steps	Teacher & Student Activities	Philosophical Values
Concept Exploration	Mathematical problem solving using ethnomathematics logic.	*Sipakainge*'
Reflection and Evaluation	Respect for group processes and individual accountability for learning outcomes.	*Siri' na Pacce*

Data validity in this study was ensured through a triangulation strategy using five validated instruments, as assessed by two mathematics education experts. This included an observation sheet to measure syntax implementation with an inter-observer reliability of 85% and a structured interview guide to explore students' subjective perceptions in depth. Academic quality was measured using a learning outcome test consisting of 10 contextual essay questions on geometry and fractions—using a pre-test and post-test design—that met the criteria for content validity (CVI = 0.92) and high reliability (Cronbach's alpha, r = 0.78). Specifically, these questions were formulated as open-ended mathematical word problems (story problems) designed to assess higher-order thinking skills, particularly at the application (C3) and analysis (C4) levels of Bloom's Taxonomy. Each item required students to not only calculate numerical answers but also write down their logical step-by-step mathematical reasoning and problem-solving strategies explicitly. Furthermore, the dynamics of sociocultural interactions were mapped using a 1–4 Likert-scale sociometric questionnaire to analyze the quality of student collaboration and a Guttman-scale response questionnaire to accurately evaluate students' learning comfort levels.

Data analysis in this study was conducted in a circular fashion, referring to the Miles, Huberman, and Saldana model, through three systematic stages—data reduction, data presentation, and conclusion drawing/verification—which were meticulously mapped to address each research question:

- For Research Question 1 (Implementation of the BBM Model): In the data reduction stage, the researcher transcribed the semi-structured interview results with the teacher and coded dominant classroom behaviors recorded during the observation of the four syntax stages. In the data presentation stage, these qualitative findings were laid out in a systematic descriptive narrative chronological to the preparation, implementation, and evaluation phases to reconstruct a transparent overview of how the Bugis-Makassar philosophy was operationalized. Verification was achieved by cross-referencing the observation sheets with the teacher's self-reflection logs.

- For Research Question 2 (Effectiveness in Improving Understanding and Character): Data reduction involved converting raw pre-test and post-test student scores into academic achievement percentages, alongside reducing the 1–4 Likert-scale and Guttman-scale questionnaires into structured matrix entries. In the data presentation stage, quantitative outcomes and sociometric relational data were presented through a correlation matrix, frequency distribution tables, and an interactive sociogram to map peer-to-peer choices (*Abbulosibatang* and *Sipakatau*). The verification stage utilized a member-checking mechanism to discuss preliminary character and cognitive findings with teachers, ensuring the researcher's structural interpretations aligned with actual classroom growth.
- For Research Question 3 (Perceptions on Reducing Learning Stigmas): The reduction stage focused on sorting, identifying, and thematic-coding the subjective feedback from student and educator interviews regarding math anxiety and difficulty stigmas. During data presentation, these thematic clusters were organized into a structured qualitative matrix supported by direct quotes from the subjects. Finally, verification was carried out through data triangulation, contrasting the recorded qualitative sentiments against the empirical responses from the Guttman-scale comfort questionnaire.

Regarding legality and subject protection, this study was conducted in compliance with ethical standards and obtained official permission from the Sinjai Regency Education Office and the principal of Elementary School 141 Pakka. All parents or guardians of students signed informed consent forms as a sign of their children's willingness to participate in the data collection process. Furthermore, the researcher guaranteed the confidentiality of students' identities by using initials in all reports and scientific publications, in accordance with applicable privacy principles and academic research ethics.

RESULT AND DISCUSSION

This qualitative research focuses on the implementation of the Culture-Based Learning (BBM) model through the integration of observation, interviews, learning achievement tests, and sociometry instruments. The synergy of these various instruments aims to measure the effectiveness of the BBM model in internalizing the values of Bugis-Makassar philosophy—*Siri'*, *Pacce*', *Abbulosibatang*, and *Sipakatau*—into mathematical logic in elementary schools. Through data triangulation, this qualitative exploration proves that Bugis-Makassar local wisdom can be a catalyst for innovation that improves students' cognitive achievement while strengthening social cohesion.

The first use of the Bugis-Makassar culture-based mathematics learning model successfully mixed cultural values with teaching, creating a balance between math skills and local knowledge by including the ideas of *Sipakatau*, *Siri'*, and the important value of mappesona ri dewata seuae. Before implementing the BBM model in the classroom, teachers must thoroughly prepare culturally responsive instructional materials through a meticulous preparation phase. Based on the interview results, this phase involves designing a comprehensive culture-based lesson plan that maps specific mathematics competencies, such as geometry and fractions, onto relevant local cultural structures. Additionally, teachers need to prepare concrete cultural artifacts or high-quality visual media, including detailed structural diagrams of traditional Bugis-Makassar stilt houses (*rumah panggung*). This is complemented by formulating open-ended contextual word problems that integrate local philosophical values, ensuring that the resulting mathematical tasks are both cognitively demanding and culturally familiar to the students.

During the active learning phase, the teacher operates the BBM model by systematically transitioning from tangible cultural artifacts to abstract mathematical concepts while embedding core philosophical ethics. This implementation follows a structured sequence that begins with a cognitive catalyst, where the teacher presents local artifacts—such as analyzing the parallel lines and angles found in stilt house pillars—leveraging the value of *AppakaSiri'* to spark intrinsic motivation and curiosity. Following this, the classroom shifts to sociocultural collaboration; students are divided into heterogeneous groups where the teacher explicitly internalizes the values of *Sipakatau* (mutual respect) and *Abbulosibatang* (unity) to guide equitable collaboration across different mathematical ability levels. The cycle concludes with ethnomathematics exploration, during which the teacher acts as a facilitator while students solve contextual problems using mathematical logic embedded in their cultural heritage, utilizing *Sipakainge*' (peer tutoring) to maintain learning momentum.

At the final stage of the learning cycle, the teacher conducts an immediate reflection and directly explains the evaluation results to the students to serve two vital pedagogical functions. First, this immediate intervention provides a critical cultural alignment with *Siri' na Pacce*; since Bugis-Makassar philosophy highly values *Siri'* (self-worth) and *Pacce* (empathy), a direct explanation allows teachers to cultivate individual accountability while fostering collective empathy, transforming mathematical errors into shared learning opportunities rather than individual failures. Second, immediate feedback is essential for preventing cognitive misconceptions, as elementary students frequently struggle to bridge local intuitive logic with formal mathematical notations. By explaining evaluation results without delay, the teacher instantly rectifies cognitive dissonance and solidifies the connection between the cultural context and abstract mathematical truths before misconceptions become deeply rooted.

The following section presents the results of the evaluation of the Bugis-Makassar culture-based mathematics learning model, which was conducted through an interview with one of the mathematics teachers.

Interviewer: What are the key achievements of this culture-based mathematics model?
Respondent: The implementation successfully integrated ethnophilosophical values like Sipakatau, Siri', and Mappesona ri Dewata Seuae into instruction. This approach improved material comprehension through teamwork driven by Abbulosibatang and Pacce'.
Interviewer: How do these values influence students' academic responsibility?
Respondent: Significantly. The Siri' value encourages students to take personal duty for their work. Beyond math skills, this established system refreshes cultural identity and builds character within a dynamic ethnomathematics environment, though reinforcing Sipakatau through awards still needs refinement.

The implementation of the Culture-Based Learning (BBM) model, which integrates Bugis-Makassar philosophy into the core learning phase, demonstrates systematic reinforcement in building students' understanding of geometry. To ensure its pedagogical efficacy, the implementation of the BBM model is structured into three highly interconnected phases: pre-implementation preparation, classroom implementation, and immediate evaluation.

The preparation phase begins with the development of culturally responsive instructional materials, where teachers design a specialized culture-based lesson plan that maps specific geometry competencies onto relevant local cultural structures. This phase also requires teachers to prepare concrete cultural artifacts or high-quality visual media, such as detailed structural diagrams of traditional Bugis-Makassar stilt houses (rumah panggung), alongside formulating open-ended contextual word problems that embed local philosophical values.

During the classroom implementation phase, the teacher operationalizes the model by transitioning from tangible cultural artifacts to abstract mathematical concepts while embedding core philosophical ethics. This is initiated through a cognitive catalyst—such as analyzing the parallel lines and angles found in stilt house pillars—leveraging the value of *AppakaSiri'* to spark intrinsic motivation. The lesson then progresses to sociocultural collaboration, where students are divided into heterogeneous groups and guided by the values of *Sipakatau* (mutual respect) and *Abbulosibatang* (unity). The process concludes with ethnomathematics exploration, during which the teacher acts as a facilitator while students solve contextual problems using mathematical logic embedded in their cultural heritage, utilizing *Sipakainge*' (peer tutoring) to maintain learning momentum.

The final phase centers on immediate evaluation and reflection, where the teacher directly explains the evaluation results to the students to serve critical pedagogical and cultural functions. Strategically, this prompt intervention aligns with the local philosophy of *Siri' na Pacce*, cultivating individual accountability while fostering collective empathy so that mathematical errors are viewed as shared learning opportunities rather than individual failures. Furthermore, this immediate feedback effectively prevents cognitive misconceptions, allowing the teacher to instantly rectify cognitive dissonance and solidify the connection between the intuitive cultural context and formal abstract geometric notations before misconceptions become deeply rooted.

Theoretically, this process aligns with the principles of ethnomathematics proposed by D'Ambrosio, where mathematics is viewed as a cultural product embedded in societal practices (D'Ambrósio & Knijnik, 2020; Rosa, 2023). Through group dynamics that uphold the values of *Abbulosibatang* (unity) and *Pacce*' (empathy), students not only engage in individual cognition but also experience socio-constructivism, as emphasized by Vygotsky. In this context, social interactions rooted in local wisdom serve as scaffolding, facilitating students' transition from concrete understanding to more abstract geometric concepts.

Furthermore, this model successfully instills personal responsibility through the manifestation of the value of *Siri'* na Pesse (*Siri'* ma*Siri'*) in completing academic assignments. The integration of these character values supports Gay's Culturally Responsive Teaching (CRT) theory, which emphasizes the importance of utilizing students' cultural backgrounds to create an adaptive and meaningful learning environment (Abdalla & Moussa, 2024; Chuang et al., 2020). By internalizing *Siri'* as an intrinsic motivation to achieve and maintain self-respect through academic performance, a structured yet flexible learning ecosystem is created in elementary schools that adapt to students' personal identities. This demonstrates that regional philosophical values can act as a catalyst in strengthening students' self-regulation throughout the instructional process.

Overall, this ethnomathematics ecosystem forms a transformative framework that focuses not only on numeracy skills but also on revitalizing cultural identity. Although the *Sipakatau* aspect of rewarding still requires further optimization, the BBM model has proven inclusive in synergizing the formal mathematics curriculum with local wisdom values. This finding is consistent with previous studies demonstrating that culture-based learning can enhance meaningful learning (Meyer & Aikenhead, 2021; Rigney et al., 2020; Zuliana et al., 2025). Progressive evaluation confirms that the synergy between regional philosophical values and cognitive learning outcomes can create a holistic educational model, where intellectual intelligence develops alongside the strengthening of character based on local wisdom.

Interviewer: How has the integration of local philosophy evolved in these geometry sessions?

Respondent: Progress was systematic. We strengthened student understanding of 3D shapes by internalizing Sipakatau (mutual respect) into our dialogue. By reinforcing Abbulosibatang (unity) and Pacce' (empathy) during group work, we transformed formulas into a humanistic, cohesive learning experience.

Interviewer: How do Siri' and Sipakatau impact motivation and the classroom climate?

Respondent: Siri' (honor) acts as a motivational stimulus; students feel a moral duty to master the material. We also optimized awards as a manifestation of Sipakatau to recognize human dignity, maturing the synergy between mathematical logic and ethics.

Interviewer: What is the long-term impact of this ecosystem?

Respondent: This model revitalized cultural identity while optimizing numeracy. Students are cognitively competent and committed to character-based learning, proving that local identity and logic coexist harmoniously.

The internalization of the value of *Sipakatau* (humanizing each other) in instructional dialogues and the stimulation of achievement motivation based on *Siri'* have transformed geometric material—such as prisms, pyramids, and cones—into a humanistic and cohesive learning experience. Theoretically, this approach aligns with the concept of culturally responsive pedagogy, which emphasizes the importance of connecting academic content with students' cultural identities to enhance cognitive engagement (Kumi-Yeboah & Amponsah, 2023; Zeng et al., 2025). Strengthening the principles of *Abbulosibatang* (unity) and *Pacce*' (empathy) in group collaboration creates space for social constructivism, where students construct mathematical understanding through meaningful social interactions. Previous studies have shown that this integration of local wisdom is effective in reducing mathematical anxiety and strengthening students' resilience in solving complex problems (Anwar et al., 2024; Harefa & Suastra, 2024).

The culmination of this innovation is marked by the maturation of the synergy between mathematical logic and sociocultural ethics, where the provision of appreciation as a concrete manifestation of *Sipakatau* reinforces the formation of a holistic educational ecosystem. This practice supports Carl Rogers' theory of humanistic education, which places respect and empathy as the primary foundations of intellectual growth (Krikorian, 2022). By integrating numeracy skills and revitalizing cultural identity, this model not only optimizes academic achievement but also builds students' commitment to continuous learning. By harmonizing local Bugis-Makassar values within the mathematics curriculum, education transforms into a means of cultural conservation and the development of 21st-century competencies based on character and ethics.

The internalization of ethnophilosophical values within the Culture-Based Learning (BBM) ecosystem demonstrates the concrete integration of Bugis-Makassarese character traits as the foundation of academic behavior in mathematics learning. To understand how these values manifest, it is necessary to examine the concrete activities students perform during the implementation of the BBM model.

- In the pre-instructional phase, students actively observe and analyze cultural artifacts, such as the architectural geometry of traditional stilt houses, which triggers their *AppakaSiri'* (motivation).
- During the Appasituju phase, students engage in heterogeneous group setups where they practice *Sipakatau* (mutual respect) and *Abbulosibatang* (unity) by negotiating roles and establishing cooperative norms within their teams.
- In the Concept Exploration phase, student activities shift toward ethnomathematics problem-solving; they physically manipulate models, debate solutions using local logical reasoning, and enact *Sipakainge*' through active peer tutoring.
- Finally, in the Reflection phase, students engage in individual and collective accountability check-ins, assessing not only their mathematical accuracy but also their adherence to ethical group dynamics based on *Siri' na Pacce*.

The qualitative results from interviews with students regarding these activities reveal a profound shift in their psychological and cognitive alignment toward mathematics. High-ability students expressed that the integration of *Siri'* gave them a strong sense of academic responsibility and self-esteem, motivating them to lead and support their peers without condescension. For instance, one student noted during the interview that explaining fractions using local sharing analogies felt like an honorable duty rather than a scholastic burden. On the other hand, interviews with medium- and low-ability students highlighted that the inclusion of *Pacce*' (empathy) and *Abbulosibatang* (unity) values created an emotionally secure classroom climate. These students reported that they no longer felt isolated or intimidated by numbers because their groups treated problem-solving as a collective endeavor. They specifically emphasized that the practice of *Sipakainge*' (mutual reminding) allowed them to ask questions comfortably, effectively eroding cognitive anxiety and building their academic self-confidence.

These empirical interview results explain the differentiated impact observed across student ability levels. In high-ability students, the *Siri'* and *Sipakatau* values steadily transformed into achievement motivation and leadership, accelerating mastery of abstract concepts. Meanwhile, in medium- and low-ability students, the *Pacce*' and *Abbulosibatang* values played a crucial role as emotional bridges to erode cognitive isolation and build self-confidence through inclusive collaboration. This dynamic demonstrates that the synergy of cultural values can create social harmony that enriches the learning experience while enhancing the cognitive performance of students at various ability levels.

Although engagement in the cognitive phase is beginning to take shape, the results of this qualitative exploration confirm that the internalization of the *Sipakatau* and *Siri'* values still face consistency challenges, particularly related to maintaining focus and ethical communication during presentations. These findings emphasize that the implementation of the BBM model is a transformative process that requires ongoing support to ensure the values of integrity and respect resonate with students' numeracy achievements. Overall, this innovation serves a dual function: as an accelerator of excellence for the upper class and as a catalyst for social inclusivity that narrows the numeracy gap for the lower class by strengthening the Bugis-Makassar cultural identity in elementary schools.

The findings show that high-ability students consistently maintain stable *Siri'* ma*Siri'* (achievement motivation) scores align with Deci and Ryan's Self-Determination Theory. In the Bugis-Makassar cultural context, *Siri'* serves as a powerful internal driver or intrinsic motivation. Consistent with previous research by Tilawah et al. (2025), *Siri'* is not simply a feeling of shame but rather a source of self-esteem that drives individuals to achieve standards of academic excellence. The increase in students' average scores from 23.75 to 59.11 demonstrates that when mathematics learning is linked to cultural self-esteem, psychological barriers to numbers tend to decrease significantly.

Furthermore, the finding regarding the situational nature of *Siri'* scores in low-ability students confirms Vygotsky's theory on the importance of the social environment, or scaffolding, in building student self-confidence (Andana et al., 2025). Through the Culture-Based Learning (BBM) model, the role of a social environment based on local wisdom is crucial in supporting students' cognitive transitions. This confirms that the implementation of Bugis-Makassar philosophy in basic mathematics not only functions as an identity reinforcement but also as an effective pedagogical strategy in mitigating ability gaps through structured and meaningful social support.

Additionally, the success of peer tutoring in this study, where high-ability students helped their peers, is a concrete manifestation of the values of *Pacce*' (empathy) and *Abbulosibatang* (unity). Theoretically, this reinforces the concept of Peer-Assisted Learning Strategies (PALS) (Hamilton-Hinch et al., 2023; Zhang & Maconochie, 2022). Consistent with studies by Foulkes and Naylor (2022), it was found that peer tutoring not only benefits the students being assisted (tutees) but also deepens the students' conceptual understanding. Within the local cultural context, the integration of this philosophy successfully transformed rigid classroom competencies into organic, mutually reinforcing collaboration.

The integration of *Abbulosibatang* values within the Culture-Based Learning (CBL) model explains why moderate-ability students experienced a 35-point jump in their scores. They felt emotionally secure within a cohesive group, thus reducing cognitive load when completing student worksheets. These findings confirm that the implementation of the Bugis-Makassar philosophy in elementary school mathematics learning creates an inclusive environment that supports equitable academic ability. By emphasizing empathy and unity as the foundation of interaction, the BBM model has been qualitatively proven to optimize numeracy achievement by strengthening social bonds based on local wisdom.

To rigorously address Research Question 2 (evaluating the model's effectiveness in improving student character) and operationalize the interpersonal mechanics of Research Question 1 (classroom implementation), the researcher explicitly examined the relationships and interaction patterns between individuals within the focus group. This interpersonal mapping is critical because, in a culture-based learning (CBL) framework, "character" is not an isolated individual trait but an active, observable practice of sociocultural values during collaboration. By tracking how students relate to one another, the researcher can objectively measure the real-world internalization of *Abbulosibatang* (unity) and *Sipakatau* (mutual respect) during mathematical problem-solving, as outlined in the methods section. Given the depth of qualitative and structural data required for this relational mapping, the sociometric analysis focused on four subjects representing distinct academic ability profiles within the group: NRN and RSN (high ability) and AKL and HTK (medium/low ability). The matrix below maps the operational choices of students when seeking or offering technical collaboration during the mathematics tasks.

Table 1. *Abbulosibatang* Sociometry Matrix

	RSN	NRN	AKL	HTK
RSN	0	1	0	0
NRN	1	0	2	0
AKL	1	2	0	0
HTK	2	1	0	0

Analysis of the *Abbulosibatang* (Solidarity) aspect shows that RSN and NRN play a central role with a Social Choice Index (SCI) of 0.67, which confirms their position as the main catalyst in the distribution of technical assistance; in contrast, HTK recorded a non-choice index of 1.00, indicating significant obstacles in the internalization of cooperative values in the environment.

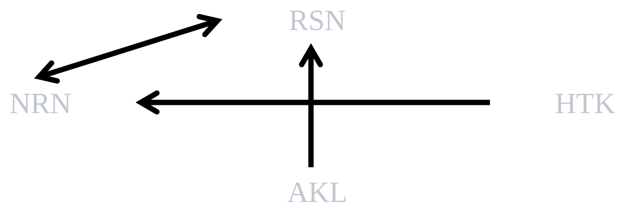

Figure 1. *Abbulosibatang* Sociogram

A sociogram analysis of the BBM learning ecosystem reveals interaction dynamics that highlight the crucial role of peer leadership through the integration of Bugis-Makassar philosophy. The emergence of central figures such as RSN and NRN students who optimize the values of *Abbulosibatang* and *Pacce*' aligns with

Coleman's Social Capital Theory, where the network of social relationships within the classroom facilitates the achievement of academic goals (Gamoran et al., 2021; Mikiewicz, 2021). Their active involvement in mentoring peers is an indicator of character strengthening and mastery of mathematical concepts through peer-mediated instruction mechanisms. Conversely, the social isolation experienced by some students indicates obstacles in internalizing the value of solidarity, which is sociometrically correlated with academic difficulty. This phenomenon confirms that the social structure of the classroom is strongly influenced by the extent to which local values are adopted as instruments of collaboration in solving numeracy problems (Salloum et al., 2017).

To provide a comprehensive view of the character outcomes required to answer Research Question 2, Tables 2 and 3 evaluate the ethical dimensions of the group, looking beyond mere technical math competence to how students perceive each other's intrinsic human value.

Table 2. *Sipakatau* Sociometry Matrix (Appreciating)

	RSN	NRN	AKL	HTK
RSN	0	0	1	2
NRN	1	0	0	2
AKL	0	1	0	2
HTK	0	1	2	0

Table 3. *Sipakatau* (Respect) Sociometric Matrix

	RSN	NRN	AKL	HTK
RSN	0	0	1	2
NRN	2	0	0	1
AKL	0	2	0	0
HTK	2	1	0	0

In a review of the *Sipakatau* (appreciation) aspect, a positive anomaly was found in which HTK and AKL subjects received very high social recognition with an index reaching 1.00 on the personal character dimension, even though both tended to be technically isolated in group dynamics. This phenomenon can be theoretically explained through the concept of social recognition in Axel Honneth's recognition theory, which emphasizes that an individual's self-esteem is not only built through functional competence but also through appreciation for moral integrity and personality qualities recognized by their community (Hetti, 2026; Lepold, 2019).

This finding directly answers Research Question 2, indicating that Bugis-Makassar sociocultural values successfully created a peer evaluation standard that transcends technical mathematical boundaries. Within this ecosystem, individual integrity still receives significant appreciation despite personal limitations in cognitive collaborative interactions. This is in line with previous studies showing that in value-based learning environments, social attraction is strongly influenced by an individual's ethical character rather than simply academic ability or practical contribution in completing group assignments (Varma, 2024).

This innovation fundamentally positions the value of *Sipakatau* as an ethical awareness to respect the dignity of others, transforming the classroom into a nursery for noble character that upholds universal humanitarian values. Through this local wisdom framework, students' numerical logic skills develop in harmony with their social maturity, which, according to D'Ambrosio's Ethnomathematics (Albanese & Perales, 2020; Hasbi & Fitri, 2026), bridges formal mathematics with cultural contexts (sociocultural cognition). These findings confirm that the BBM model serves not only as a pedagogical framework for cognitive development but also as a medium for revitalizing an inclusive cultural identity.

The student learning outcomes in this study represent the transformation of mathematical competence achieved through the consistent internalization of learning experiences based on local wisdom values. To evaluate the effectiveness of the Culture-Based Learning (BBM) model intervention, comprehensive measurements were conducted through pre- and post-tests designed to map the development of students' cognitive understanding within an ethnomathematics framework. This evaluation aimed to determine the extent to which the integration of Bugis-Makassar philosophy significantly impacted their mastery of mathematics material at the elementary school level.

Through descriptive statistical analysis, this study presents objective data on students' initial achievement before the implementation of the BBM model, which serves as a fundamental basis for measuring the significance of improvements in students' mathematical abilities. The results indicate that the synergy between numerical logic and Bugis-Makassar noble values not only improved academic scores but also strengthened student engagement in the learning process. These findings confirm that the BBM model is effective as a bridge between the formal curriculum and local values to optimize students' cognitive potential and character sustainably.

Table 4. Results of Descriptive Statistical Analysis for Tests Before Implementing the BBM Model

Statistic	Value
Subject	28
Ideal Score	100
Highest Score	75
Lowest Score	0
Range	75
Mean	23,75
Median	20
Standard Deviation	19,80

The results of the initial analysis before the implementation of the Culture-Based Learning (BBM) model showed that students' cognitive achievement was still at a low level, with an average score of 23.75 and a standard deviation of 19.80. This data serves as a fundamental reference point confirming the existence of a significant gap in students' mathematical understanding before being given an intervention based on Bugis-Makassar philosophy, which is theoretically aligned with Piaget's Constructivism view that new knowledge must be built on existing schemes. This low initial achievement is often associated with the phenomenon of cultural discontinuity, where there is a separation between school materials and students' sociocultural realities, as explained in the study of culturally responsive teaching (Rosa & Orey, 2020). Therefore, this condition emphasizes the urgency of implementing a more contextual and integrative learning strategy, which can bridge mathematical abstraction with local wisdom to increase the relevance and efficacy of instruction at the elementary school level.

Table 5. Distribution of Learning Outcome Scores Before Implementing the BBM Model

Score Interval	Category	Frequency	Percentage (%)
0-34	Very low	23	82,14
35-54	Low	2	7,14
55-64	Moderate	1	3,57
65-84	High	2	7,14
85-100	Very high	0	0,00
Total		28	100

Table 6. Results of Descriptive Statistical Analysis for Tests After Implementing the BBM Model

Statistic	Value
Subject	28
Ideal Score	100
Highest Score	95
Lowest Score	15
Range	80
Mean	59,11
Median	62,5
Standard Deviation	23,26

After implementing the Culture-Based Learning (BBM) model, there was a significant increase in students' cognitive achievement with an average score of 59.11 and a standard deviation of 23.26. This empirical surge demonstrates the effectiveness of the integration of Bugis-Makassar philosophy in optimizing students' mathematical understanding, while also proving that the local wisdom approach can transform academic competencies progressively compared to initial observation results. Theoretically, this finding strengthens David Ausubel's concept of meaningful learning, which states that learning becomes more effective when new material is linked to students' existing cognitive structures and cultural backgrounds (Agra et al., 2019; Bryce & Blown, 2024). Furthermore, this result is in line with various previous studies on ethnomathematics, which show that the use of sociocultural context as a pedagogical bridge can reduce cognitive barriers and increase knowledge retention (Batiibwe, 2025). Thus, the BBM model successfully validates that instructional success in elementary schools is greatly influenced by the synergy between formal curriculum content and philosophical values that exist in students' social environments.

Table 7. Distribution of Learning Outcome Scores After Implementing the BBM Model

Score Interval	Category	Frequency	Percentage (%)
0-34	Very low	5	17,86
35-54	Low	6	21,43
55-64	Moderate	4	14,29
65-84	High	10	35,71
85-100	Very high	3	10,71
Jumlah		28	100

The implementation of the Culture-Based Learning (BBM) model significantly improved students' cognitive achievement across all ability levels, as reflected in the increase in average scores from 23.75 to 59.11. The synergy between the Bugis-Makassar cultural pillars proved to be a key catalyst in this transformation of learning outcomes, where achievement motivation (*Siri'*) encouraged high-ability students to exceed the Minimum Completion Criteria to achieve scores above 85, while the values of solidarity (*Abbulosibatang*), caring through peer tutoring (*Pacce*'), and mutual respect (*Sipakatau*) became crucial factors that stimulated score increases in medium-ability students (up to 35 points) and low-ability students (up to 15 points). Theoretically, these findings validate the differentiated learning theory integrated with culturally responsive teaching, where an inclusive and meaningful learning environment can accommodate the diversity of students' cognitive profiles through the bridge of local philosophy (Gheyssens et al., 2022; Kieran & Anderson, 2019). The results of this study are consistent with previous studies on ethnomathematics, which show that the use of regional character values not only strengthens interpersonal aspects but also empirically optimizes mastery of mathematical concepts by creating a classroom ecosystem that is supportive, transformative, and relevant to students' sociocultural identities in elementary schools (Prahmana, 2022).

The analysis of student responses revealed a very high level of acceptance of the Culture-Based Learning (BBM) model. The response survey showed a very positive level of acceptance of the BBM model (Table 8).

Table 8. Summary of Student Responses to the BBM Model

Response Indicators	Number of Students Agreeing (n)	Percentage of Agree (%)
Enthusiasm for learning components	28	100.00
Novelty of learning model +2	27	96.43
Clarity of language in textbooks and worksheets +2	26	92.86
Interest in continuing the model in the future	28	100.00

The quantifiable data in Table 8 indicates an overwhelmingly positive reception of the BBM model among the fifth-grade cohort. Rather than just reflecting numerical benchmarks, these figures signify a profound shift in the students' psychological and cognitive engagement with mathematics. The absolute consensus in student enthusiasm (n = 28; 100.00%) indicates that the BBM model successfully transformed the traditionally rigid mathematics classroom into an interactive, fun, and culturally familiar learning atmosphere. By shifting the pedagogical focus from passive formula-memorization to active hands-on exploration of local artifacts (such as analyzing stilt houses), the model eliminated learning boredom and high math anxiety. Similarly, the perfect score for the students' interest in continuing the model in the future (n = 28; 100.00%) serves as strong evidence that when abstract numerical principles are anchored in students' lived experiences and local identity, mathematics is no longer perceived as a detached or foreign discipline but as a meaningful tool relevant to their daily lives.

Furthermore, the high agreement regarding the novelty of the learning model (n = 27; 96.43%) demonstrates that the structural integration of Bugis-Makassar philosophical values provided a refreshing and highly distinctive alternative to the conventional, urban-centric materials that students usually encounter. This sense of novelty stimulated their cognitive curiosity. Lastly, the high-rating for-language clarity in textbooks and worksheets (n = 26; 92.86%) carries a vital instructional meaning: it proves that using ethnomathematics frameworks and local philosophical analogies (*Sipakatau*, *Pacce*', and *Abbulosibatang*) acts as a clear cognitive bridge. This approach does not complicate or impede student understanding; instead, it refines communication clarity and helps elementary students easily digest complex concepts of geometry and fractions by tapping into their pre-existing cultural schema.

Theoretically, these data validate Albert Bandura's Self-Efficacy Theory, stating that a culturally relevant learning environment can increase students' confidence in their ability to complete complex mathematical tasks (Street et al., 2017). This successful knowledge transfer demonstrates that the synergy between numerical logic and local wisdom successfully reduces cognitive barriers, creating a fun learning atmosphere that reflects the cultural identity of elementary school students.

Overall, this positive response confirms that the BBM model successfully integrates Bugis-Makassar philosophy as an instrument to increase universal learning interest and motivation in the classroom. The unanimous agreement from all participants (100%) to continue implementing this model in the future provides strong empirical evidence for the effectiveness of Culturally Responsive Teaching (CRT) in the mathematics curriculum. Previous studies have confirmed that when learning transforms from a rigid cognitive burden to an inclusive, character-based intellectual journey, student engagement increases dramatically (Supianti et al., 2025). These findings position the BBM model not simply as an instructional strategy but as a holistic approach capable of fostering students' intrinsic interest in mathematics by reinforcing regional values.

The finding regarding gender differences in moderate-ability students—where female students demonstrate higher consistency in aspects of *Sipakatau*—is closely related to Gilligan's study on the ethics of care. The study suggests that females tend to place a greater emphasis on maintaining interpersonal relationships in social interactions (Abbott, 2025; Josselson, 2023). On the other hand, teachers' challenges in managing emotions when students' concentration declines indicate that implementing *Sipakatau* requires high emotional intelligence to ensure pedagogical authority remains aligned with humanitarian values. This confirms that the success of the BBM model depends heavily on teachers' ability to consistently contextualize local wisdom in the classroom.

One of the most original findings in this study is the influence of family background on the manifestation of cultural values in the classroom. Students living without parents (living independently with grandparents) tend to emphasize the value of *Sipakatau* more as a form of social adaptation. This aligns with Bronfenbrenner's Ecological Systems Theory, which states that the microsystem (family) significantly influences how individuals interact within the mesosystem, or school (Flynn & Mathias, 2025; Hu et al., 2025). Conversely, the lack of internalization of *Abbulosibatang* in subjects living with extended families indicates a sense of excessive security that reduces motivation for collaboration. These findings make an important contribution to the development of the Culture-Based Learning (BBM) model, which emphasizes that cultural approaches must be differentiated based on students' psychosocial profiles to ensure effective mathematics learning.

The innovation of the BBM model demonstrates that mathematics is not simply the manipulation of numbers, but rather a cultural practice capable of transforming the classroom into a miniature ideal of Bugis-Makassar society, where academic success is inseparable from social integrity. This research makes a significant scientific contribution to the field of ethnomathematics and character development by combining mathematical logic through four main principles: *Siri'*, *Pacce*', *Abbulosibatang*, and *Sipakatau*. Practically, the use of *Pacce*'-based peer tutoring and collaboration through the *Abbulosibatang* spirit has proven effective in reducing learning barriers in middle- and low-ability students. With a 100%

positive response, this innovation not only increases learning interest but also revitalizes cultural identity within an inclusive elementary mathematics curriculum.

CONCLUSION

This study confirms that the integration of Bugis-Makassar philosophy into the BBM Model goes beyond simply using ethnomathematics as a material object but rather establishes it as a pedagogical framework capable of reconciling the tension between abstract cognition and cultural identity. The study's novel contribution lies in transforming the values of *Siri'*, *Pacce*', *Abbulosibatang*, and *Sipakatau* from mere moral values into operational strategies in mathematics learning that effectively mitigate students' sociopsychological barriers. These findings offer a new paradigm that numeracy efficacy in elementary schools depends not only on sophisticated cognitive aids but also on the revitalization of sociocultural values that serve as ethical foundations and drivers of organic collaboration through empathy-based peer tutoring mechanisms. Thus, the BBM Model makes a theoretical contribution to education literature by demonstrating that a curriculum based on local wisdom can be a systematic instrument for achieving academic excellence while simultaneously strengthening students' character.

While this study provides in-depth insights, several limitations warrant consideration. Among them is the limited sample size of a single classroom, which may generalize the findings to the Bugis-Makassar cultural context. Furthermore, the use of a descriptive-exploratory qualitative design aimed at exploring the phenomenon in depth rather than establish a rigid causal relationship, further reinforced by the absence of a control group, preventing the model's effectiveness from being measured through pure statistical comparisons. Finally, the relatively short duration of the intervention limits the ability to evaluate the retention of cultural values and the long-term learning outcomes of the subjects.

Building upon the findings of this study, it is recommended that the Education Office and policymakers integrate the BBM Model into the local content curriculum and the Pancasila Student Profile Strengthening Project (P5) framework in South Sulawesi. This is supported by the development of standardized implementation guidelines by LPTKs for teacher training programs and the adoption of the *Sipakatau* and *Abbulosibatang* pillars by practitioners as standards for inclusive classroom management. Implications for further research include the need to expand validity through quasi-experimental designs to test causal relationships, longitudinal studies to monitor the consistency of internalization of cultural values, and cross-cultural comparative studies to evaluate the flexibility of this philosophical framework in other regions. Furthermore, the development of digital technology-based learning media that integrate local values is crucial for increasing the appeal and accessibility of mathematics materials in the future.

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