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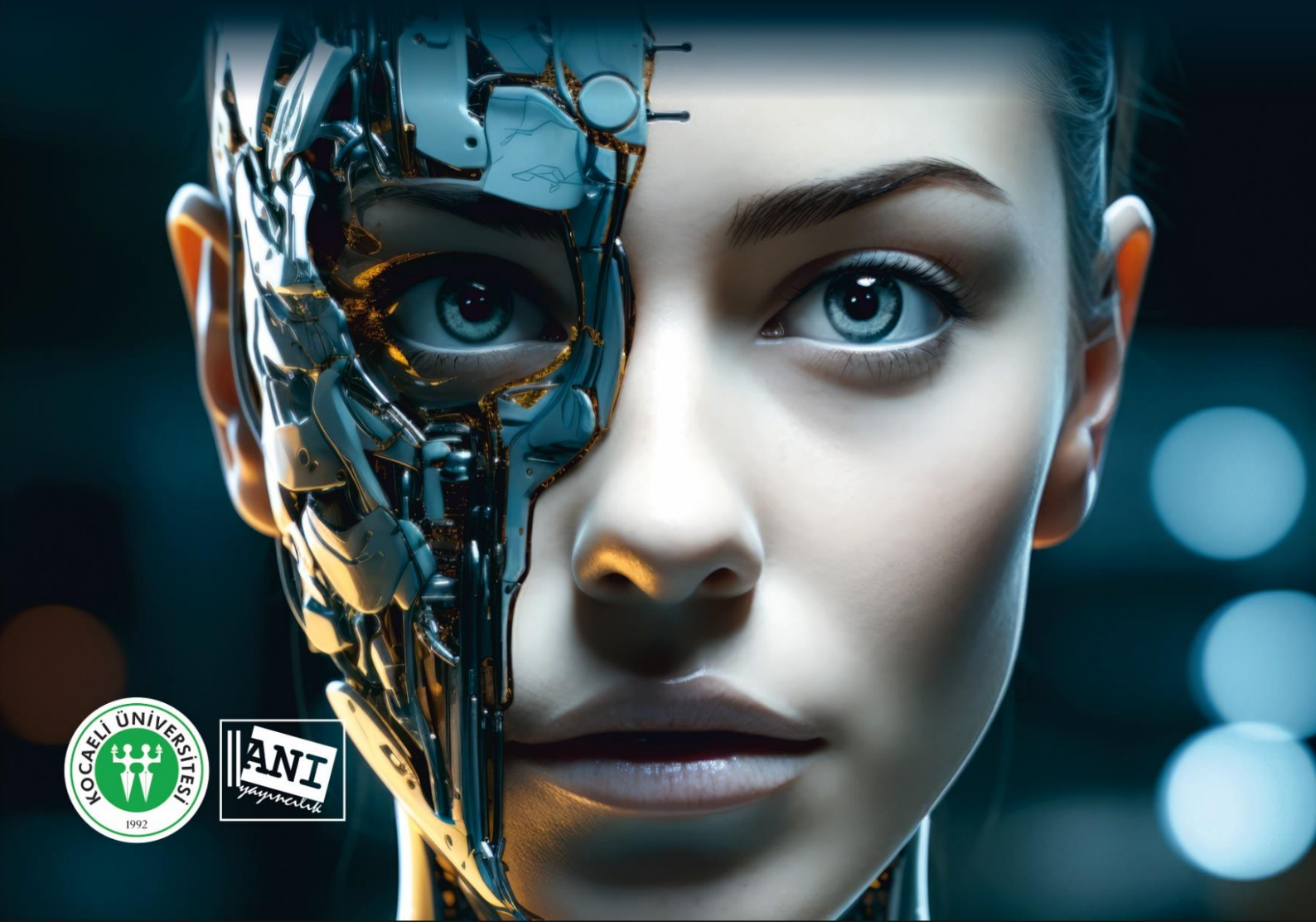
# XI International Eurasian Educational Research Congress

# CONFERENCE PROCEEDINGS



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XI INTERNATIONAL EURASIAN

EDUCATIONAL RESEARCH CONGRESS

# EJERCONGRESS 2024

# CONFERENCE PROCEEDINGS

May 21-24, 2024/ Kocaeli University - Türkiye

**Editor**

Distinguished Professor Şenel POYRAZLI,

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INTERNATIONAL EJER CONGRESS

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# Main Theme

***"Designing the Future: Changing Paradigms and Transhumanism with Artificial Intelligence in Education"***

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# Sub-Themes

- Academic freedom, autonomy, and social responsibility in education
- Artificial intelligence and educational applications
- Augmented reality applications
- Barriers to learning
- Blended learning
- Computer-assisted measurement and evaluation
- Core skill sets for students and teachers
- Design of school buildings in the future
- Designing and delivering a digital strategy
- Digital competence
- Digital parenting
- Distance Education
- Earthquake Education
- Post Earthquake Trauma Training
- Earthquake and Effective Psychosocial Intervention Methods
- Earthquake and Trauma
- The Impact of Earthquakes on School Staff
- Education and society
- Education for healthy living and healthy communities
- Education for a sustainable life
- Education in the digital age: Primary, secondary, high school, higher education, and application examples
- Educational leadership in the digital age
- Effects of regional differences on education
- Equity, Diversity, and Inclusion Related to Marginalized Groups
- Emergency Management at Schools
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# Author Information

*This book has been compiled with contributions from 61 authors representing 35 different universities in Turkiye, the United States, and Iran, as well as Turkiye's Ministry of National Education. Among the contributors, there are 51 authors from 31 universities 6 authors from education institutions in Turkey, 3 authors from 2 universities in the United States, and 1 author from a university in Iran.*

# CONTENTS

# Mathematics in Cultural Context: A Framework for Developing and Implementing EthnoSTEAM-Oriented Lesson Plans

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**Abstract**

This study investigates the integration of EthnoSTEAM into mathematics education, focusing on the importance of incorporating students' cultural contexts to enhance their learning experiences. Traditional mathematics education often fails to account for the cultural backgrounds of students, hindering their ability to connect mathematical concepts to real-life situations. EthnoSTEAM—a multidisciplinary approach that combines ethnographic and cultural perspectives with STEAM fields—seeks to bridge this gap by infusing cultural diversity into the curriculum. The study employs a qualitative research approach, structured into three stages. Initially, a literature review was conducted to identify gaps in existing research on EthnoSTEAM-oriented mathematics education. This informed the design of professional development training for teachers on the EthnoSTEAM approach. In the second stage, teachers collaborated to co-design lesson plans that integrated students' cultural contexts, guided by both theoretical frameworks and literature review insights. These lesson plans were implemented in classrooms during the third stage, with student performance, participation, and feedback closely observed, and teacher experiences documented through interviews and diaries. The research adopted a qualitative approach, utilizing a design-based research model. Data were collected through various forms, subjected to document analysis, and analyzed using descriptive and content analysis methods. Preliminary findings suggest that EthnoSTEAM-oriented lesson plans significantly enhance student engagement and motivation, making mathematics more relevant and meaningful. In this context, a framework for the application of the EthnoSTEAM approach to mathematics courses is presented. However, further comprehensive analysis and long-term monitoring are necessary to fully understand the impact on student achievement and to guide broader implementation strategies.

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***Keywords:*** *Culture-based STEAM studies, Culture and mathematics, EthnoSTEAM lesson plans, Ethnomathematics, Design-based research*

## Introduction

Mathematics education plays a crucial role in equipping students with the skills needed to navigate and solve real-world problems. However, traditional approaches to teaching mathematics often emphasize abstract, universal concepts without adequately considering the cultural contexts of students' daily lives. This disconnect can lead to disengagement, particularly among students from diverse cultural backgrounds, as they struggle to see the relevance of mathematical concepts in their personal experiences (Gutstein, 2006; Crumer, 2024). Perry (2022) suggested that to boost STEM engagement, teachers should involve local communities in school projects, focus on culturally or regionally relevant concepts, and incorporate project-based learning.

Addressing these challenges requires an innovative approach that integrates cultural contexts into STEM education, particularly in mathematics. The theoretical foundation of this study is rooted in the EthnoSTEAM approach, a culturally motivated research framework that integrates ethnographic and cultural perspectives into the fields of Science, Technology, Engineering, Arts, and Mathematics (Chahine & De Beer, 2020). EthnoSTEAM emphasizes the significance of incorporating students' cultural contexts and ethnic origins into their educational experiences, recognizing that such integration enhances both engagement and learning outcomes. This approach is supported by constructivist and multicultural education theories, which underscore the importance of contextualizing learning within students' cultural experiences (Ladson-Billings, 1995; Banks, 2015). Existing studies and theories advocate for the inclusion of cultural diversity in educational practices, arguing that students learn more effectively when their cultural backgrounds are acknowledged and valued. Research by Gutstein (2006) and González, Moll, & Amanti (2006) has demonstrated the positive impact of culturally relevant pedagogy on student motivation and achievement, particularly in mathematics. Furthermore, the integration of STEAM fields with cultural approaches has been highlighted as a crucial step in creating a more inclusive and relevant curriculum (Chahine, 2019; Kirikcilar, 2023). By merging these disciplines with cultural contexts, EthnoSTEAM seeks to bridge the gap between students' lived experiences and the academic content they encounter, fostering a more holistic and meaningful educational experience (Roberts, 2012; Sudarmin, 2018). While previous studies have explored the integration of cultural contexts into various educational disciplines, there remains a significant gap in the literature regarding the systematic application of EthnoSTEAM in mathematics education. This research seeks to fill that gap by developing a framework for the preparation and

implementation of EthnoSTEAM-oriented mathematics lesson plans. This framework is intended to guide educators in creating culturally responsive curricula that enhance student engagement and understanding.

The originality of this study lies in its focus on the co-creation of lesson plans with teachers and the in-class application of these plans. By involving educators in the design process, the research aims to ensure that the lesson plans are both practical and effective. Additionally, the study's qualitative approach provides a comprehensive analysis of how EthnoSTEAM-oriented lessons impact student learning and teacher experiences, offering valuable insights into the benefits and challenges of this educational strategy.

The integration of cultural perspectives into STEAM education has gained increasing attention as a means to create more inclusive and relevant learning experiences. Chahine (2019) and Kirikcilar (2023) have highlighted the potential of EthnoSTEAM to transform educational practices by integrating cultural perspectives into STEAM fields. Their work underscores the need for curricula that reflect students' cultural identities and promote equity in education. However, empirical studies on the implementation of EthnoSTEAM in mathematics classrooms remain limited, indicating a need for further exploration of this approach's effectiveness.

This study builds on these foundational works by providing a practical framework for integrating EthnoSTEAM into mathematics education and evaluating its impact on student engagement and learning outcomes. By doing so, it aims to contribute to the growing body of literature on culturally responsive teaching and offer actionable insights for educators seeking to create more inclusive and effective learning environments.

## Problem Statement

Mathematics education is vital in developing students' mathematical thinking and instilling fundamental values that are key to their personal growth and contributions to society (MEB, 2017; MEB, 2018). However, traditional approaches to mathematics education often neglect the cultural contexts of students, particularly those from diverse backgrounds. This cultural neglect in mathematics education, as noted by Bishop (1988), hinders students' ability to apply mathematical concepts in their daily lives, which is especially challenging for immigrant students (OECD, 2015; Suárez-Orozco & Anderson, 2023). Furthermore, educators are increasingly called upon to create inclusive environments that integrate sustainability and environmental education (Sims, Rocque, & Desmarais, 2021). Addressing these challenges requires a shift towards culturally responsive teaching practices that recognize and incorporate the diverse cultural backgrounds of students, ensuring that all students can engage meaningfully with mathematical concepts and apply them in their lives. Also, some studies emphasize that students' culture plays a crucial role in their mathematics learning, and incorporating students' cultural backgrounds and experiences into math instruction positively impacts both their academic success and overall life (Bonotto, 2010; Delpit, 1995; Gay, 2010; Weldeana, 2016; Sharma & Orey, 2017). The problem statement has created the need for a framework for the use of the EthnoSTEAM approach, which is required as a result of these studies.

## Method

### *Research Design*

The research employs a qualitative and design-based research model to explore the integration of EthnoSTEAM into mathematics education. The reason for using this method is that it is used in the creation of an innovative product (such as a new learning environment, a new educational application, or a new theory), which is the basic feature of design-based research (Kuzu, Çankaya, & Mısırlı, 2011). The design-based research model is particularly suited for this study as it focuses on the iterative process of developing and refining educational interventions through collaboration with practitioners in real-world settings. This model allows for the continuous improvement of the EthnoSTEAM-oriented lesson plans as they are co-created, implemented, and evaluated in classroom settings.

### *Stages of Research*

The study is structured into three main stages, each focusing on a specific aspect of the EthnoSTEAM integration process:

**Literature Review and Theoretical Framework Development.** The first stage involves an extensive review of existing literature on EthnoSTEAM, culturally relevant pedagogy, and mathematics education. This review aims to identify gaps in current research and establish a solid theoretical foundation for the study. The findings from this literature review guide the development of a theoretical framework that underpins the design and implementation of EthnoSTEAM-oriented lesson plans.

**Co-Design of Lesson Plans.** In the second stage, the research shifts to the co-design process, where teachers collaborate with researchers to develop lesson plans that integrate EthnoSTEAM principles. This collaborative process is grounded in constructivist and multicultural education theories, ensuring that the lesson plans are culturally responsive and aligned with the theoretical framework established in the first stage. The co-design process is iterative, with lesson plans being refined based on ongoing feedback from teachers.

**Implementation and Data Collection.** The third stage involves the classroom implementation of the co-designed lesson plans. During this phase, data is collected through multiple qualitative methods, including classroom observations, teacher interviews, and student feedback. These data collection methods aim to capture the experiences and perceptions of both teachers and students regarding the effectiveness of EthnoSTEAM-oriented lessons. Observations focus on student engagement, participation, and the relevance of mathematical concepts to students' cultural contexts, while interviews and diaries provide deeper insights into the challenges and successes of implementing EthnoSTEAM in the classroom.

### *Data Collection and Analysis*

**Data Collection.** Various forms of data are gathered, including lesson plans, classroom observation notes, interview transcripts, and student feedback forms. This diverse set of data sources allows for a comprehensive analysis of the impact of EthnoSTEAM on teaching and learning.

**Data Analysis.** The collected data undergoes document analysis and is analyzed using descriptive and content analysis techniques. Descriptive analysis is used to summarize and describe the observable patterns and trends in student engagement and participation. Content analysis is employed to systematically categorize and interpret qualitative data from interviews, observations, and teacher diaries, focusing on recurring themes related to cultural relevance, student motivation, and the practical challenges of implementing EthnoSTEAM.

**Iterative Refinement.** Throughout the study, the design-based research model supports iterative refinement of the lesson plans and instructional strategies. Feedback loops between stages allow for continuous improvement of the EthnoSTEAM approach, ensuring that it remains responsive to the needs of both students and teachers. This iterative process also contributes to the study's validity by allowing for real-time adjustments based on empirical findings.

**Expected Outcomes.** The qualitative design-based research approach is expected to yield rich, contextually grounded insights into the integration of EthnoSTEAM into mathematics education. By involving teachers in the co-design process and focusing on classroom implementation, the study aims to produce practical, scalable strategies for enhancing student engagement and learning outcomes through culturally responsive mathematics education.

## Findings

The results of this study indicate that the implementation of EthnoSTEAM-oriented mathematics lesson plans had a positive impact on both student engagement and understanding of mathematical concepts. The analysis of qualitative data provides insights into the effectiveness of this approach in diverse classroom settings.

### *Increased Student Engagement*

One of the most significant findings was the noticeable increase in student engagement during EthnoSTEAM lessons. Observational data revealed that students were more attentive and actively participated in class discussions and activities. Teachers reported that students displayed greater enthusiasm and curiosity, particularly when lessons incorporated cultural elements relevant to their own experiences.

### *Enhanced Understanding of Mathematical Concepts*

Teachers noted that students were able to apply mathematical concepts more effectively when they were contextualized within familiar cultural frameworks. For instance, lessons that incorporated traditional patterns and designs from students' cultural backgrounds helped them better grasp geometric and spatial reasoning.

### *Positive Teacher Feedback*

Interviews with teachers highlighted the benefits and challenges of implementing EthnoSTEAM-oriented lesson plans. Teachers expressed appreciation for the professional development training, which equipped them with the skills and knowledge necessary to integrate cultural contexts into their teaching. They reported that the collaborative lesson planning process enhanced their confidence and creativity in designing culturally relevant curricula.

However, some teachers also noted challenges, such as the need for additional resources and time to develop EthnoSTEAM lesson plans. Despite these challenges, the majority of teachers believed that the benefits outweighed the difficulties, as the approach enriched students' learning experiences and fostered a more inclusive classroom environment.

### *Overall Impact*

Overall, the results of this study demonstrate that EthnoSTEAM-oriented mathematics lesson plans have the potential to transform traditional math education by making it more engaging and culturally relevant. The positive outcomes observed in student engagement, understanding, and teacher experiences underscore the value of integrating cultural perspectives into the mathematics curriculum. These findings support the continued exploration and implementation of EthnoSTEAM approaches in diverse educational settings.

Based on all the findings, a framework is presented below for using the EthnoSTEAM approach in mathematics lesson plans. This table organizes the framework into clear components, activities, and expected outcomes, providing a structured approach to integrating EthnoSTEAM into math classrooms.

**Table 1**

*A Framework for EthnoSTEAM Applications*

| Component | Description | Key Activities/Strategies | Expected Outcomes |
|---|---|---|---|
| **Foundation and Rationale** | Recognizing the importance of cultural contexts in enhancing students' learning experiences in mathematics education. | Identify the gap in traditional math education. Establish the need for EthnoSTEAM integration. | Enhanced relevance and inclusivity in math education. Acknowledgment of cultural diversity in curriculum design. |
| **Objectives** | To increase student engagement, improve understanding, and promote equity through culturally responsive | Engage students by incorporating their cultural backgrounds. Ensure lessons are practical and applicable to daily life. | Higher student motivation and engagement. Improved application of mathematical concepts in real-life contexts |

| | | | |
|---|---|---|---|
| | teaching practices in mathematics. | | |
| **Literature Review and Theoretical Foundation** | Conduct a comprehensive review to identify gaps and establish a theoretical basis for EthnoSTEAM. | Review existing research on EthnoSTEAM and related pedagogical theories. Develop a solid theoretical framework. | A well-grounded framework that informs the design and implementation of EthnoSTEAM lesson plans. |
| **Co-Design of Lesson Plans** | Collaborative creation of lesson plans integrating cultural contexts with math concepts. | Work with teachers to co-design culturally relevant lesson plans. Iteratively refine plans based on feedback and testing. | Culturally responsive lesson plans that are effective and practical. Enhanced teacher creativity and involvement in curriculum design. |
| **Professional Development for Educators** | Equip teachers with the skills and knowledge to implement EthnoSTEAM-oriented lesson plans effectively. | Develop training programs focused on EthnoSTEAM. Provide ongoing support and resources. | Teachers are empowered and confident in applying EthnoSTEAM principles in their classrooms. Increased teacher engagement in cultural pedagogy. |
| **Classroom Implementation** | Actual application of the co-designed lesson plans in diverse classroom settings. | Implement lesson plans in real classroom settings. Observe and record student engagement and understanding. | Increased student engagement and improved comprehension of mathematical concepts. Practical insights into lesson plan effectiveness. |
| **Data Collection and Analysis** | Collect and analyze data to assess the impact of EthnoSTEAM lesson plans on teaching and learning. | Gather data from multiple sources. - Conduct descriptive and content analysis to identify key patterns and themes. | Comprehensive understanding of the impact of EthnoSTEAM on student outcomes. - Identification of challenges and areas for improvement |
| **Iterative Refinement and Evaluation** | Continuous improvement of lesson plans and instructional strategies based on empirical findings and feedback | Apply feedback loops to refine lesson plans. Conduct ongoing evaluations to ensure the effectiveness of the EthnoSTEAM approach. | Enhanced lesson plans that are responsive to the needs of both students and teachers. Sustained improvement in educational outcomes. |
| **Recommendations** | Propose strategies for broader implementation and further research on EthnoSTEAM in mathematics education. | Suggest professional development, resource allocation, curriculum reform, community involvement, and further research. | Broader adoption of EthnoSTEAM principles in educational settings. - Long-term improvements in student engagement, motivation, and achievement |

The framework for integrating EthnoSTEAM into math classrooms outlines a structured approach to creating a culturally responsive and inclusive learning environment. It emphasizes the importance of acknowledging students' cultural backgrounds and incorporates these into mathematics education to enhance engagement, understanding, and equity. Key components include setting a strong foundation rooted in cultural relevance, co-designing lesson plans with educators, and providing continuous professional development for teachers. The framework also focuses on the practical implementation of EthnoSTEAM in classrooms, supported by ongoing data collection and analysis to refine and improve teaching strategies. By integrating cultural contexts into math education, the framework aims to make learning more meaningful and applicable to students' daily lives, ultimately fostering better educational outcomes.

An EthnoSTEAM-oriented lesson plan should also include several key components to effectively integrate students' cultural contexts into the mathematics lesson plans. Here are the essential elements:

***Cultural Relevance***

Contextualized Math Problems: Develop problems that reflect students' cultural experiences and community contexts. For instance, use culturally significant patterns or local practices to illustrate mathematical concepts.

Incorporation of Local Knowledge: Integrate traditional practices or indigenous knowledge systems that relate to mathematical ideas, such as geometry or measurement.

***Interdisciplinary Integration***

Connections to Other STEAM Fields: Encourage exploration of how mathematics intersects with other STEAM disciplines through cultural lenses. For example, examine the mathematical principles used in local architecture or art.

Ethnographic Methods: Utilize community surveys or interviews to explore the application of mathematical concepts in cultural practices, fostering a deeper understanding of both math and cultural heritage.

***Student-Centered Learning***

Empowerment of Students: Involve students in the co-creation of knowledge by allowing them to contribute their cultural experiences to the lesson design.

Responsive Teaching: Adapt teaching methods to align with students' cultural identities, using relevant examples and communication styles.

***Equity and Inclusivity***

Addressing Cultural Bias: Identify and eliminate biases in traditional math education to ensure inclusivity, particularly for marginalized or minority students.

Social Justice Focus: Use math education to explore social justice issues, encouraging students to apply mathematical reasoning to real-world community challenges.

***Reflective Practice***

Continuous Reflection: Teachers should reflect on their cultural assumptions and biases, considering their impact on teaching.

Feedback Mechanisms: Regularly seek student feedback on the cultural relevance of lessons and be willing to adapt teaching strategies accordingly.

***Community and Collaboration***

Engagement with Local Communities: Collaborate with community members to identify cultural resources that can be integrated into the curriculum.

Collaborative Lesson Design: Work with fellow educators to co-design lesson plans that reflect cultural diversity and relevance.

***Assessment and Evaluation***

Culturally Responsive Assessment: Develop assessment methods that consider cultural contexts and provide a fair evaluation of student understanding.

Ongoing Evaluation: Implement mechanisms to assess the effectiveness of EthnoSTEAM-oriented lessons in enhancing student engagement and understanding.

These components collectively foster a more inclusive, engaging, and relevant mathematics education that respects and incorporates the diverse cultural backgrounds of students.

***Discussion***

The findings of this study highlight the effectiveness of EthnoSTEAM-oriented mathematics education in enhancing student engagement and understanding by incorporating cultural contexts into the curriculum. The increased student interest and improved comprehension of mathematical concepts suggest that culturally relevant pedagogical approaches can significantly impact students' learning experiences.

**Cultural Relevance and Student Engagement.** The study demonstrates that students are more engaged and motivated to learn when lessons are aligned with their cultural backgrounds. This aligns with previous research, which emphasizes the importance of culturally responsive teaching in promoting student interest and participation (Ladson-Billings, 1995; Gutstein, 2006; Johnson & Elliott, 2020). By contextualizing mathematical concepts within students' cultural frameworks, EthnoSTEAM creates a more inclusive learning environment that values diversity and promotes equity.

**Improved Mathematical Understanding.** The significant improvement in student assessment scores indicates that EthnoSTEAM not only engages students but also enhances their understanding of mathematics. This finding supports the notion that culturally relevant education can improve academic outcomes, particularly for students from diverse backgrounds (González et al., 2005; Banks, 2015). By connecting mathematical concepts to real-life cultural examples, students can better comprehend and apply these concepts, leading to deeper learning.

**Teacher Experiences and Challenges.** While implementing EthnoSTEAM-oriented lesson plans was generally positive, teachers identified challenges such as the need for additional resources, time, and workload (Park et al., 2016; Jamil, Linder & Stegelin, 2018; Herro, Quigley & Cian, 2019). These challenges highlight the importance of providing ongoing professional development and support for educators as they adapt to new teaching approaches. Despite these hurdles, teachers expressed a strong belief in the benefits of EthnoSTEAM, noting that it enriched their teaching practices and enhanced student learning.

***Conclusion***

This study underscores the transformative potential of EthnoSTEAM-oriented mathematics education in fostering cultural relevance and engagement in diverse classrooms. By integrating students' cultural contexts into the curriculum, EthnoSTEAM makes mathematics more meaningful and accessible, thereby enhancing student motivation and understanding. The positive outcomes observed in this study indicate that culturally responsive teaching approaches can play a critical role in improving educational equity and academic success.

The study contributes to the growing body of literature on EthnoSTEAM and culturally responsive education, offering practical insights into the design and implementation of culturally relevant curricula. It highlights the need for continued exploration and support for educators seeking to integrate cultural perspectives into their teaching practices.

***Recommendations***

Based on the findings of this study, the following recommendations are proposed to enhance the implementation of EthnoSTEAM in mathematics education:

- Professional Development: Schools should provide ongoing professional development opportunities for teachers to learn about EthnoSTEAM approaches and develop culturally responsive lesson plans. This training should include strategies for integrating cultural contexts into mathematics curricula and opportunities for collaboration with colleagues.
- Resource Allocation: Educational institutions should allocate resources to support the development and implementation of EthnoSTEAM-oriented lesson plans. This includes providing access to culturally relevant teaching materials and creating time for teachers to collaborate on lesson planning.
- Curriculum Development: Curriculum developers should prioritize the inclusion of cultural contexts and diverse perspectives in mathematics education. By incorporating EthnoSTEAM principles into curriculum standards, educators can ensure that lessons are relevant and engaging for all students.
- Research and Evaluation: Further research is needed to evaluate the long-term effects of EthnoSTEAM on student achievement and motivation. Future studies should focus on collecting and analyzing data on student performance

and engagement over extended periods to assess the sustained impact of EthnoSTEAM-oriented education.

- Community Involvement: Schools should engage with local communities to identify cultural resources and perspectives that can be integrated into the mathematics curriculum. By involving community members in the educational process, educators can create more authentic and meaningful learning experiences for students.

Implementing these recommendations will help educators and policymakers create more inclusive and culturally responsive educational environments that support the success of all students.

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