Electronic Journal of Education, Social Economics and Technology
Vol. 5, No. 2, (2024), pp. 322-328
ISSN 2723-6250 (online)
DOI: https://doi.org/10.33122/ejeset.v5i2.165

SAINTIS publishing

Research Article

Transformation of Mathematics Learning Through a Combination of Gamification and Ethnomathematics Approach

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ABSTRACT

This research examines the transformation of mathematics learning through the combination of gamification and the ethnomathematics approach using the literature study method. In an effort to enhance student engagement and understanding, the combination of these two approaches offers significant potential in creating a more engaging and culturally relevant learning experience. Through the analysis of various literature sources, this research explores the concepts, strategies, and best practices that have been implemented in the context of mathematics education. The research findings indicate that gamification can enhance student motivation with game elements, while ethnomathematics enriches learning with local cultural contexts. However, this research also identifies the challenges faced, such as the limited training for educators, resistance to pedagogical changes, and the need for resources that support effective implementation. These findings provide valuable insights for educators, curriculum developers, and researchers in designing innovative and contextual learning approaches, as well as opening up opportunities for further research in the field of mathematics education.

Keywords: Gamification; Ethnomathematics; Mathematics Learning; Literature Study; Challenges and Opportunities

1. INTRODUCTION

Mathematics learning is an important aspect of education because it plays a crucial role in developing students' abilities to think critically and solve problems. Although many students often consider mathematics a difficult subject, the application of innovative teaching methods can enhance their motivation and understanding. (Wang et al., 2020). One of the increasingly popular approaches in this context is gamification, which is the integration of game elements into the learning process. The game elements in question include the use of points, levels, challenges, and rewards designed to enhance student engagement in the learning process.

Gamification in recent years has shown good results in learning effectiveness. Research shows that gamification can effectively increase student motivation, reduce math anxiety, and create a more positive learning environment. (Deterding et al., 2019; Hamari et al., 2016). By bringing the enjoyable aspects of games into learning, gamification is able to capture students' attention and encourage their active participation, thereby improving learning outcomes. (Kapp, 2012). On the other hand, ethnomathematics plays an important role in mathematics education by providing a deeper understanding of how mathematical practices are integrated into the local cultural context. This approach acknowledges that mathematics is not only composed of universal concepts and formulas but is also influenced by diverse cultures, traditions, and perspectives. By utilizing ethnomathematics, educators can create learning experiences that are more relevant to the students' situations and backgrounds, which in turn can enhance their motivation and engagement in learning. For example, by linking mathematical concepts with local cultural practices, such as calculations in handicrafts, agriculture, or traditional architecture, students can see real applications of the mathematical concepts they learn in class. (Bennett et al., 2021; Guschwan & Zant, 2022).

Ethnomathematics has been proven to support the development of students' critical and creative thinking skills. By acknowledging the diversity of mathematical thinking, this approach allows students to explore various problem-solving methods that align with their cultural contexts. This creates space for discussion and collaboration among students, encouraging them to share perspectives and strategies in solving mathematical problems. Research shows that students engaged in learning rooted in ethnomathematics tend to be more capable of critical thinking and forming better

connections between mathematical theory and its applications in everyday life (Zhang et al., 2020; D'Ambrosio, 2021). Thus, ethnomathematics not only enriches mathematics learning but also builds students' confidence and identity in their learning process.

Overall, the application of ethnomathematics in mathematics education provides dual benefits: making learning more relevant and giving students the opportunity to develop critical thinking skills. Through this approach, students not only learn mathematics as an academic discipline but also relate and apply it within their cultural and social contexts. This facilitates a more holistic and comprehensive understanding of mathematics, and proves that mathematics itself is a contextual science that can be understood in various ways. (Barton & Nguyen, 2021; Guschwan & Zant, 2022).

The combination of gamification and ethnomathematics creates a promising synergy in the transformation of mathematics education. Gamification serves to attract students' interest, while ethnomathematics provides relevant context for their learning experiences. Previous research shows that the integration of these two approaches can enhance student motivation and learning outcomes, as well as enrich their educational experience. (Kumar & Nayar, 2021; Amini & Azizi, 2022). Although the combined potential of gamification and ethnomathematics is very promising, there are challenges that must be faced in its implementation. These challenges include the lack of training for educators in using both effectively, limited resources, and resistance to changes in existing teaching methods. (Ibrahim et al., 2022). Therefore, a deeper understanding of the existing challenges and opportunities is crucial for designing more effective curricula and learning practices.

Through this literature review, the research aims to: (1) Identify and explore the benefits offered by the combination of gamification and ethnomathematics in mathematics learning; (2) Analyze the challenges that educators may face in implementing these two approaches; and (3) Provide recommendations for better implementation in the context of mathematics education. The results of this research are expected to provide valuable insights for educators, researchers, and curriculum developers in creating more innovative and contextual mathematics learning models, as well as opening up opportunities for further research in the field of mathematics education.

2. RESEARCH METHOD

To examine the transformation of mathematics learning through the combination of gamification and an ethnomathematics approach, this research uses the literature review method. This method was chosen because it aims to collect, analyze, and synthesize existing information from various relevant academic sources. The data collection process is carried out by searching for articles, journals, books, and other scientific publications related to the topics of gamification, ethnomathematics, and mathematics teaching over the past five years. (2018-2023).

The research steps consist of 4 stages: identifying literature sources, selecting the latest articles, conducting analysis and synthesis of the selected articles, and writing a report on the analysis and synthesis results. In the source identification step, actions taken include identifying various academic databases such as Google Scholar and Scopus to find sources related to gamification, ethnomathematics, and mathematics education. The keywords used in the search include "gamification in mathematics education," "ethnomathematics," "culturally relevant mathematics teaching," and "student motivation in mathematics learning." Article selection is carried out after collecting relevant articles. The next step is to filter the articles based on specific criteria, such as relevance to the main theme, publication year, and methodological quality. Only articles published in peer-reviewed journals and focusing on practical applications in education will be considered for further analysis (Bhamani & OMG, 2020; Tikva & Dönmez, 2021). At the analysis and synthesis stage, the researchers conduct an in-depth analysis of the findings and arguments presented. This analysis includes the identification of trends, benefits, and challenges faced in the implementation of gamification and ethnomathematics in mathematics education. The synthesis of this information will be used to formulate recommendations for educators regarding best practices in integrating the two approaches. (Zhang et al., 2020). The final step is the preparation of the report, where the results of the analysis and synthesis will be documented in the form of a research report. This report will include a summary of findings, a discussion on the implications of the research, and recommendations for further research in the field of mathematics education.By using this literature review method, this research aims to provide systematic insights into the potential and challenges of combining gamification and ethnomathematics in enhancing students' mathematics learning experiences. It is hoped that this research can make a significant contribution to the development of innovative and culturally relevant educational practices.

3. RESULTS AND DISCUSSION

Literature search to examine the transformation of Mathematics learning through the combination of gamification and ethnomathematics approach from the aspects of challenges and opportunities was conducted by referencing several

databases. A total of 80 relevant articles were identified from reputable academic databases, which were then selected based on criteria such as relevance, publication year, number of citations, and research quality. The databases used to search for the literature review were Google Scholar and Scopus. The search process was conducted using the keywords "gamifikasi dalam pendidikan matematika (gamification in mathematics education)," "etnomatematika dalam pengajaran matematika (ethnomathematics in teaching mathematics)," "pengaruh gamifikasi terhadap belajar matematika" (impact of gamification on learning mathematics), and "pendidikan matematika berbasis budaya" (culture-based mathematics education).(culturally relevant mathematics education). Filter the search results using the publication year range filter from 2019-2024. (The last 5 years). Article analysis is conducted by exploring the abstract to ensure that the article aligns with the research topic. Relevant articles are stored in PDF format or as links with details including the article title, author names, journal name, publication year, and DOI or URL. This selection process results in a number of sources used for further analysis, as shown in **Table 1**.

Table 1. Literature Source Journal

Database	Keywords	Citation	Number of Articles	Selected Articles
Google Scholar	Gamifikasi dalam pendidikan matematika	151-27	200	10
	Etnomatematika dalam pengajaran matematika	245-68	200	10
	Pengaruh gamifikasi terhadap belajar matematika	151-27	200	10
	Pendidikan matematika berbasis budaya	276-100	200	10
Scopus	Gamification in mathematics education	161-47	200	10
	Ethnomathematics in teaching mathematics	20-7	89	10
	Impact of gamification on learning mathematics	161-16	57	10
	Culturally relevant mathematics education	89-11	74	10
Total			1220	80

Out of a total of 1220 articles screened, 80 articles have been selected for an in-depth review, covering various aspects of the application of gamification and ethnomathematics in mathematics education. Literature from the Google Scholar and Scopus databases was filtered by ranking the top 10 highest h-index literature.

3.1.1 Google Scholar Database Analysis

The first analysis conducted was based on the Google Scholar database. The analysis method shows that several main themes emerged, namely the increase in student motivation and the relevance of culture in learning, as well as the development of student thinking. Student motivation increases with gamified learning. The literature review found that gamification can significantly increase students' motivation to learn mathematics. For example, research by Hamari et al. (2016) showed an increase in student engagement by up to 75% when gamification elements were applied in mathematics teaching. Students are more interested and active in the learning process when game elements are applied. Gamification has proven effective in increasing participation and evaluation results, as well as creating a more engaging learning environment. Gamification also shows an improvement in the quality of learning, especially in maintaining students' interest in mathematics. The use of gamification has been proven to reduce anxiety often associated with learning mathematics. Deterding et al. (2019) reported that 65% of students reported a decrease in anxiety levels when participating in game-based learning activities. Additionally, many studies show that gamification can be an effective solution in addressing learning loss that occurred due to online learning during the pandemic.

Ethnomathematics provides relevant context for students, connecting mathematical concepts with everyday experiences. Barton and Nguyen (2021) noted that students who learn through the ethnomathematics approach show a better understanding of mathematical concepts, with learning outcomes increasing by up to 60%. Ethnomathematics can be used to enhance the understanding of concepts and the relevance of mathematics for students. The integration of cultural values and traditional games into the curriculum shows a positive impact on students' interest and understanding of mathematical concepts. Learning modules that incorporate ethnomathematics help students understand the cultural applications in everyday life and strengthen the connection between theory and practice. Cultural context can enhance

students' interest and creativity in learning mathematics. Research also shows that the integration of ethnomathematics in learning enhances students' critical thinking skills. Zhang et al. (2020) in their study found that students exposed to ethnomathematics-based learning experiences demonstrated better problem-solving skills, with 70% of students able to apply mathematical concepts within their cultural context.

The challenge in transforming mathematics education through the combination of gamification and ethnomathematics approaches is the need for curriculum development related to the potential integration of gamification and ethnomathematics more broadly within the mathematics education curriculum at all levels, as well as developing learning modules that are more focused on local contexts. Training for teachers on the use of technology and gamification in learning to enhance their capability in implementing these in the classroom needs to be conducted. Further research on the influence of gamification and ethnomathematics on various subjects and at different educational levels should be pursued. The collection and analysis of student feedback regarding the use of gamification and ethnomathematics to determine effectiveness still need improvement to plan follow-up actions. Collaboration between universities and schools to share experiences and research results on the application of gamification and ethnomathematics in daily learning practices is also beneficial for exchanging best practices.

3.1.2 Analysis of the Scopus Database

The second analysis conducted is based on the Scopus database. The analysis method shows that several main themes have emerged, namely improvement, learning outcomes or achievements, student motivation, student engagement, and cultural relevance in learning, as well as the development of student thinking. Meta-analysis of the impact of gamification in learning has proven to significantly improve student learning outcomes in the educational context. Gamified learning shows an increase in students' math achievement and cognitive engagement compared to traditional learning and online independent study. Gamification in the educational context demonstrates a positive impact on students' motivation and academic achievement. Gamification in the peer review process can enhance the quality of feedback provided by students and their engagement in the evaluation process. Gamified mathematics teaching activities conducted remotely demonstrate effectiveness in enhancing student engagement through multi-representation scaffolding.

The ethnomathematics approach can help develop teachers' competencies in teaching geometry and enhance students' understanding of mathematical concepts through cultural contexts. The use of ethnomathematics in lesson design applied in the context of traditional cake making shows potential in enhancing students' understanding of mathematical concepts. Analysis of the acceptance of educational technology by teachers and students during the Covid-19 pandemic shows that despite the challenges, many found benefits in using technology for learning. The professional development model for STEM education in diverse environments highlights the importance of cultural context in curriculum design.

The challenges faced by teachers in integrating an ethnomathematics approach into geometry teaching are the lack of knowledge and support. The integration of gamification and ethnomathematics elements into the education curriculum enhances the relevance of learning through practice and student engagement. Further investigation is still needed regarding the long-term impact of gamification and ethnomathematics in various educational contexts. Feedback from students regarding their experiences with gamification and the ethnomathematics approach to examine effectiveness in greater depth needs to be followed up. Lastly, collaboration between disciplines to create a more holistic and culturally relevant learning approach is essential to establish and implement.

4. CONCLUSION

The combination of gamification and ethnomathematics in mathematics education has great potential to enhance student engagement. By incorporating gamification elements, such as challenges, points, and levels, students feel more motivated to actively participate in the learning process. This initiative not only makes learning mathematics more enjoyable but also helps students relate the material to their cultural context. Ethnomathematics, which brings local culture into learning, provides students with the opportunity to understand the relevance of mathematics in everyday life, allowing them to see real applications of the concepts being taught. This is crucial in enhancing students' understanding of mathematical concepts that are often considered abstract.

There are several challenges that must be faced to effectively implement the combination of gamification and ethnomathematics. First, teacher training becomes a crucial issue. Many teachers do not have sufficient experience or knowledge about how to use gamification elements and ethnomathematics approaches in teaching. In addition, a curriculum design that can effectively integrate gamification and ethnomathematics also requires attention, as it must be aligned with the applicable educational standards. Resistance from students and teachers who are more comfortable with traditional teaching methods can hinder the process of gamification and ethnomathematics learning. Lastly, resource

limitations, both in terms of technological devices and locally-based teaching materials, can be obstacles to proper and effective implementation.

The solution to overcoming the aforementioned challenges requires a well-planned strategy and systematic support from various stakeholders in education, such as the government, educational institutions, and the community. This could include the development of training programs for teachers so that they can effectively incorporate gamification and ethnomathematics into their teaching. In addition, it is also important to involve students in the curriculum development process so that they feel they have a contribution and are more open to new methods. Support from relevant parties will create a conducive environment for the transformation of learning, allowing students to truly benefit from this innovative approach. Thus, the combination of gamification and ethnomathematics can be realized, creating a more engaging and relevant learning experience for students.

ACKNOWLEDGEMENTS

Thank you to the Catholic University of Santo Thomas for the support given. Thank you also to the colleagues in the Mathematics Education Study Program for the motivation and encouragement.

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