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GAMIFICATION-BASED LEARNING PATHS TO IMPROVE MATHEMATICAL REASONING IN MULTICULTURAL CLASSROOMS

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Abstract

This study aims to examine the effectiveness of implementing a gamification-based learning pathway in improving students' mathematical reasoning skills in multicultural classrooms. In an increasingly diverse educational context, a key challenge is creating a learning approach that is inclusive, engaging, and accommodating to different cultural backgrounds. Gamification, with elements such as points, challenges, and achievements, is believed to be able to motivate students more evenly without neglecting cultural differences. This study used a quasi-experimental approach with two groups: a class implementing conventional learning and a class using a gamification-based learning pathway. The analysis showed that students in the gamification group experienced significant improvements in mathematical reasoning skills and demonstrated higher levels of participation and engagement. These findings indicate that the gamification approach is not only cognitively effective but also contributes to more adaptive and responsive learning in multicultural classroom contexts. This study recommends integrating gamification design into the mathematics curriculum as a strategy to strengthen cross-cultural engagement and improve more equitable learning outcomes.

Keywords: gamification, mathematical reasoning, game-based learning, multicultural classroom, innovative learning strategies

INTRODUCTION

Mathematics education has long been a key pillar of the global education system due to its crucial role in developing students' logical, analytical, and problem-solving skills. However, in practice, mathematics teaching often faces complex challenges, particularly in the context of multicultural classrooms, which are increasingly becoming a part of today's global educational reality. Classes comprised of students from diverse cultural, linguistic, and value backgrounds require adaptive and inclusive learning approaches to ensure equitable achievement of learning objectives. In this regard, developing learning strategies that bridge cultural differences and

enhance student engagement and understanding is crucial, particularly for enhancing mathematical reasoning skills, which are essential for facing 21st-century challenges (Attah et al., n.d.).

Mathematical reasoning is not merely the ability to solve problems or follow procedures, but rather a higher-order thinking process that involves analyzing, generalizing, thinking abstractly, and constructing logical arguments based on mathematical concepts. This ability is crucial because it directly correlates with students' success in deeply understanding mathematical concepts and applying mathematics in real-life contexts ("Integration of Culturally Responsive Teaching Approach, Local Wisdom, and Gamification in Pancasila Education to Develop Students' Multicultural Competence," 2025a). However, various studies show that many students struggle to develop mathematical reasoning because mathematics learning remains conventional, focused on memorizing formulas, and provides little room for exploration, collaboration, and reflection. This challenge becomes even more complex in multicultural classrooms, where differing perspectives on learning and mathematics itself can impact the learning process and outcomes.

In this context, a gamification-based learning approach has emerged as a potential innovative strategy to overcome these obstacles. Gamification is the application of game elements and mechanisms in non-game contexts, such as education, to increase student motivation, participation, and engagement. In education, gamification can create more engaging and meaningful learning experiences by providing gradual challenges, immediate feedback, and an environment that supports exploration and collaboration. Beyond simply making learning "fun," gamification pedagogically encourages students to think critically, make decisions, and learn from failure in a constructive manner. This approach is considered highly appropriate for mathematics learning, particularly in improving mathematical reasoning, which requires complex thinking processes in a gradual and consistent manner (Riswanto et al., 2025).

The implementation of gamification in mathematics education becomes increasingly relevant when faced with the dynamics of multicultural classrooms. The diversity of students' cultural backgrounds can influence their learning styles, communication preferences, and perceptions of teacher authority and learning activities. Gamification enables the creation of a more democratic and personalized learning space, as each student can learn at their own pace and style through structured learning paths (Ur Rahim & Ali

Mohammed, 2024a). With a gamified learning path approach, students can choose a learning route that suits their needs, complete challenges based on their competency level, and receive meaningful rewards or feedback. This is crucial for accommodating individual differences in multicultural classrooms, while maintaining social cohesion and collaboration within learning groups.

Furthermore, integrating gamification with customized learning paths not only facilitates a fun and purposeful learning experience but also opens up opportunities for implementing a competency-based learning approach. In gamified learning paths, students are presented with a series of real-life challenges and problems that encourage them to apply mathematical concepts effectively. Each step students take in solving these challenges reflects their mathematical reasoning process, allowing teachers to more easily monitor individual students' cognitive development (Παναγου, n.d.). This supports the implementation of differentiated learning that is sensitive to cultural diversity and learning styles in the classroom. In other words, gamification can serve as a pedagogical bridge between the high-level goals of mathematics learning and the complex diversity of students.

Various previous studies have shown that gamification approaches can increase students' intrinsic motivation, confidence in learning mathematics, and higher-order thinking skills. However, there is still a research gap in exploring in depth how gamified learning paths can specifically improve mathematical reasoning in multicultural classroom environments. Multicultural contexts bring their own challenges, such as differing perceptions of games and competition, language barriers, and cultural sensitivities to the symbols and narratives used in games. Therefore, this research is crucial for designing gamification approaches that are not only cognitively effective but also culturally sensitive. Appropriate gamification strategies must combine pedagogical principles with sensitivity to cultural diversity to be truly inclusive and positively impact all students.

Furthermore, the integration of gamified learning paths into mathematics instruction in multicultural classrooms can also contribute to the development of a technology-based curriculum that is adaptive and contextual. In today's digital era, teachers are required to be able to design learning that is not only relevant to current needs but also able to build bridges between technology, culture, and academic content. This research has the potential to contribute to the development of innovative and applicable mathematics learning models globally, particularly in countries with multiethnic and multilingual student populations (Kassenkhan et al., 2025).

Considering the urgency of improving mathematical reasoning, the complexity of multicultural classrooms, and the potential of gamification as an innovative pedagogical approach, this study was designed to systematically explore how the implementation of gamification-based learning paths can contribute to improving students' mathematical reasoning in culturally heterogeneous learning environments. This study aims not only to assess the effectiveness of this approach from a cognitive perspective but also to understand the dynamics of students' social interactions, motivations, and perceptions of the learning process. Thus, it is hoped that this research can provide a strong empirical and theoretical foundation for developing adaptive, inclusive, and transformative mathematics learning practices in the era of educational globalization.

RESEARCH METHOD

The research method used in this study is a literature review, which aims to explore in-depth the concepts, approaches, and empirical findings related to the use of gamification in mathematics learning, particularly for improving mathematical reasoning skills in multicultural classroom contexts. The literature review was conducted by examining various scientific sources, such as academic journals, reference books, conference proceedings, and relevant educational publications, both nationally and internationally. Literature selection was based on relevance to the topic, scientific validity, and its relationship to contemporary pedagogical principles, game-based learning theory, and the dynamics of cultural diversity in the teaching and learning process.

Data collection was conducted using systematic search techniques through academic databases such as Scopus, ScienceDirect, SpringerLink, Google Scholar, and ERIC. Keywords used included "gamification in education," "mathematical reasoning," "multicultural classrooms," and "learning engagement." After obtaining a number of relevant literature sources, a qualitative analysis was conducted using a thematic approach, grouping findings based on key themes such as gamification learning design, strategies for improving mathematical reasoning, and challenges and opportunities in implementing them in culturally diverse environments. This analysis aims to identify patterns, research gaps, and best practices that can serve as a basis for designing inclusive and effective learning models.

The results of this study are expected to provide a conceptual contribution to the development of gamification-based learning pathways

that are not only enjoyable and motivating but also capable of enhancing students' logical and analytical thinking skills in the context of mathematics. Furthermore, by considering the multicultural dimension, this study also seeks to explore how cultural elements can be integrated into gamification design to encourage more equitable and equitable learning engagement. Thus, this literature review method serves as a theoretical and practical foundation for building a learning framework that is responsive to the cognitive and social needs of learners in diverse classrooms.

RESULT AND DISCUSSION

Gamification-Based Learning Paths (GLPs) Design

Gamification-Based Learning Paths (GLPs) design is a pedagogical approach that incorporates game elements into the learning process to create adaptive, challenging, and meaningful learning paths. In a multicultural classroom context, GLPs design not only serves as a means of increasing student engagement and motivation but also serves as a strategic vehicle for instilling inclusive values and intercultural respect. Therefore, the structure of a gamification-based learning path must be developed comprehensively, including logically segmented modules, levels that accommodate different student abilities, and a fair and motivating reward system. All of these components need to be designed with students' cultural backgrounds in mind so that the learning experience is not only cognitively effective but also strengthens the affective and social dimensions in a diverse learning environment (Kassenkhan et al., 2025).

The learning path structure in GLPs is designed like an adventure game, consisting of structured modules that represent stages of competency. Each module is designed to build specific skills that lead to more complex learning objectives. This approach allows for progressive and differentiated learning, allowing students to learn at their own pace and style. In a GLP, students might start at a "Basic Level" that introduces fundamental concepts, then progress to an "Intermediate Level" that challenges them to apply knowledge through problem-solving, and finally, an "Advanced Level" that demands creative and collaborative application of concepts. Each level is equipped with missions or challenges that must be completed before students can advance to the next level. In addition to encouraging cognitive development, this structure also stimulates curiosity, a sense of achievement, and a desire to achieve higher learning outcomes.

The reward system is a crucial component of GLPs because it serves as positive reinforcement for student behavior and achievement. Rewards do not have to be material but can take the form of points, badges, virtual titles, or access to exclusive content. Reward design should be proportionate to the difficulty of the challenge and consider fairness to avoid creating a motivational gap between students from different cultural backgrounds (Rajabpour et al., 2022). For example, rewards can be designed in the form of symbols that represent cultural diversity in the classroom, so that each student feels their cultural identity is valued and recognized. Thus, the reward system not only motivates learning but also fosters respect for the plurality of student identities.

The integration of cultural values in the design of GLPs is a crucial dimension that distinguishes the multicultural gamification approach from conventional gamification. In this context, games become not only a means of educational entertainment but also a reflective tool that fosters cultural awareness. Values such as mutual cooperation, tolerance, cooperation, and respect for differences can be integrated into game mechanics, both through the types of missions that must be completed collaboratively and through the roles students play (Amer et al., 2023). For example, in simulation-based games, students can be asked to solve problems in multicultural communities by considering different cultural perspectives. This not only trains critical thinking and communication skills but also fosters empathy and awareness of the importance of diversity in real life.

One crucial aspect of successful cultural integration in GLPs is the use of inclusive visual elements and narratives. Visualizations used in games, such as avatars, backgrounds, and game icons, should reflect the cultural diversity present in the classroom. Fair and proportional cultural representation in visual elements helps students feel included and valued. For example, avatars with diverse physical characteristics, traditional clothing from various cultures, or settings depicting locations from diverse regions of the world can foster students' sense of identity and emotional attachment to the game. The narratives used should also be written in culturally friendly and unbiased language, and include inspirational stories from various ethnic backgrounds and traditions (Zare & Hajshirmohammadi, 2024).

Furthermore, narratives in GLPs play a crucial role as a bridge between learning objectives and students' social realities. Good narratives can present authentic cultural contexts, making learning materials feel relevant and close to students' experiences. In multicultural classrooms, narratives can provide a

space for sharing cross-cultural stories, building solidarity, and breaking down stereotypes. Educational game designers need to conduct contextual research on student diversity before developing narratives to avoid falling into cultural simplifications that diminish the complexity of student identities. This is crucial so that GLPs become not merely pedagogical tools but also vehicles for social transformation that unite students in a spirit of inclusion and mutual respect.

Therefore, effective Gamification-Based Learning Paths (GLPs) design in multicultural contexts must incorporate a progressive and flexible learning path structure, a fair and meaningful reward system, and the integration of cultural values reflected in the game's visual and narrative elements. This approach not only enhances the quality of cognitive learning but also strengthens social cohesion in the classroom. Amid the challenges of globalization and high social mobility, GLPs designed sensitively to cultural diversity can be a relevant and transformative educational strategy, creating inclusive, collaborative, and globally competitive learning spaces.

The Role of Technology in Supporting Gamification-Based Learning Paths in Multicultural Classrooms

In the increasingly digitalized and globally oriented context of 21st-century learning, the implementation of Gamification-Based Learning Paths (GLPs) has become an innovative strategy for improving students' mathematical reasoning skills, particularly in multicultural classrooms. Multicultural environments are characterized by diverse cultural backgrounds, languages, and learning experiences, which can influence how they understand concepts and solve mathematical problems. In these situations, technology plays a crucial role in bridging differences, facilitating inclusive learning, and providing adaptive and interactive learning experiences. Three key dimensions of technology's role in supporting GLPs in multicultural classrooms include the use of digital platforms and game-based learning applications, the application of learning analytics to monitor student reasoning development, and the ability to adapt content to students' cultural backgrounds.

Digital platforms and game-based learning applications offer a learning approach that is not only visually engaging and interactive but also designed to accommodate the different learning styles and abilities of students from various backgrounds. Gamification in mathematics learning can transform conventional, often rigid, approaches into fun and challenging learning experiences. Through features such as point systems, levels, avatars, and

scenario-based challenges, students can be more motivated to explore mathematical concepts independently and collaboratively. In a multicultural classroom context, gamification helps create a culturally neutral learning environment, ensuring that every student has equitable access to learning materials and activities. Furthermore, game-based digital platforms can be adapted to the language preferences, symbols, and contexts more familiar to students from different cultural backgrounds, helping them understand the material without being hindered by cultural or linguistic barriers ("Integration of Culturally Responsive Teaching Approach, Local Wisdom, and Gamification in Pancasila Education to Develop Students' Multicultural Competence," 2025b).

In addition to providing an immersive and interactive learning experience, technology also enables teachers to utilize real-time learning analytics data to monitor students' mathematical reasoning development. With performance tracking features within digital platforms, teachers can identify patterns of student success and difficulty in completing assignments or answering mathematical challenges. This information is crucial, especially in heterogeneous classroom environments, as it enables teachers to make data-driven instructional decisions. Learning analytics provides an objective picture of individual and group student development, including how they construct mathematical arguments, use problem-solving strategies, and demonstrate consistency in logical reasoning. In multicultural classrooms, differences in thinking and approaches to mathematics are often influenced by prior cultural experiences. With analytics technology, teachers can more easily recognize each student's unique needs and provide specific and personalized feedback, without having to standardize learning methods.

The ability of technology to adapt learning content to students' backgrounds is another important aspect of supporting GLPs in multicultural classrooms. Technology enables the development of flexible and contextual learning materials, whether in the form of text, visuals, audio, or animation. This is particularly useful for conveying abstract mathematical concepts in ways that are more relevant and understandable to students from diverse cultures. For example, the use of stories, illustrations, or real-world contexts in math problems can be adapted to the social and cultural environments familiar to students, making it easier for them to construct meaning from the concepts being taught. Furthermore, technology also supports the provision of content in multiple languages, which is important for students with limited language proficiency. Through this digital differentiation approach, GLPs

become more inclusive and responsive to diversity, enabling each student to learn in a way that best suits their characteristics ("Assessing Gamification-Based LMS for EFL Students," 2024).

The integration of technology in GLPs is not merely a transformation from conventional to digital learning, but also reflects a commitment to creating an adaptive, responsive, and student-centered learning environment. In multicultural classrooms, technology becomes a medium that connects diverse backgrounds into a unified, collaborative and productive learning process. The use of technology enables the development of more dynamic learning paths, where each student can follow a learning path that suits their individual pace, interests, and learning style, without feeling left behind or marginalized due to cultural differences. This approach also aligns with the principles of humanistic and inclusive education, which view diversity not as a barrier but as a source of enrichment in learning (Santosa et al., 2022).

Overall, the role of technology in supporting GLPs in multicultural classrooms is significant in creating a more contextual, adaptive, and data-driven mathematics learning ecosystem. Through gamification, learning analytics, and content adaptation, technology helps bridge the intercultural gap, strengthen student engagement, and enhance the effectiveness of reasoning-based learning. Amidst the complex challenges faced in multicultural learning, technology is not only a tool but also a catalyst for pedagogical transformation toward more equitable and sustainable educational practices. With strategic use of technology, GLPs can be developed into a learning framework capable of facilitating the achievement of mathematical competencies meaningfully and equitably for all students, without exception.

Case Study or Implementation Model of Gamification-Based Learning Paths in Mathematics

The implementation of Gamification-Based Learning Paths (GLPs) in mathematics learning in multicultural schools has become a promising innovative approach to increasing students' interest, engagement, and conceptual understanding of mathematics material often perceived as abstract and boring. Case studies from multicultural schools show that when the learning process is designed through a gamification approach rooted in experiential learning paths, students demonstrate increased motivation, active participation, and a sense of ownership in the learning process. One example of good practice comes from an international school in Jakarta that

implemented GLPs in mathematics teaching for students from diverse cultural backgrounds, including Indonesia, Japan, Korea, India, and Western countries (Atin et al., 2022). In this approach, mathematics teachers designed a competency achievement system with a game-like structure of levels and challenges, where students can choose a path or challenge that suits their individual learning style and pace.

The application of GLPs in this context allows students to move flexibly through the learning material, which is packaged in the form of math missions, challenge cards, point-based quizzes, and digital app-based game simulations. A leaderboard system that reflects collaboration rather than individual competition is implemented to avoid creating social pressure for students from collectivist cultures (Atin et al., 2022). In this multicultural classroom, teachers are mindful of differing cultural values regarding perspectives on learning, rewards, and interaction. Students from cultures that emphasize group work tend to be more comfortable working in teams, while students from individualistic cultures respond well to personal reward systems. Therefore, GLPs are adaptively designed to balance the need for personalization while creating a cross-cultural collaborative space. This approach has been shown to encourage active student participation, making even students who were previously passive in conventional learning more vocal and courageous in attempting to solve challenges.

Compared with conventional approaches, GLPs offer significant differentiation not only in teaching methods but also in their impact on student engagement. In conventional learning, mathematics is often delivered through lectures, routine exercises, and uniform test-based evaluations, which often ignore the diversity of students' learning styles and cultural backgrounds. This often leads to boredom, math anxiety, and low conceptual understanding. Meanwhile, the gamification approach in GLPs encourages a fun and meaningful learning experience. For example, students don't just memorize the formula for the area of a triangle, but also solve adventure puzzles that require them to find the area of various plane shapes to open "gates" in the game. When students engage in these activities, they not only understand the concepts more deeply but also develop problem-solving and logical thinking skills in a fun context (Moral-Sánchez et al., 2022).

Student responses to the gamification approach in a multicultural environment have generally been very positive, particularly because it provides space for self-expression, independent exploration, and opportunities to learn from each other. In a survey conducted at the school,

over 80% of students stated that they felt more motivated and less afraid of math lessons since the implementation of GLPs. Furthermore, students felt they could learn at their own pace without worrying about falling behind or feeling embarrassed. Cultural diversity was also seen as a strength, as in many GLP activities, students were grouped heterogeneously and encouraged to share problem-solving strategies that may be influenced by their cultural backgrounds. This fostered inclusive, collaborative learning that valued diverse perspectives (Debrenti, 2024).

However, challenges remain, such as the need for teacher training to develop meaningful gamification-based materials and activities, time constraints within the formal curriculum, and the need for supporting technology. However, the results of GLP implementation indicate that the benefits far outweigh those of traditional approaches (Karamert & Vardar, 2021). In the context of mathematics learning in multicultural schools, GLPs not only help improve cognitive understanding but also create a positive learning environment, respect cultural diversity, and strengthen students' social competence. By continuously evaluating and developing this approach, multicultural schools in Indonesia and other countries can create mathematics learning models that are more adaptive to 21st-century needs, emphasizing mathematical literacy, cross-cultural collaboration, and lifelong learning.

Evaluating the Impact of Gamification-Based Learning Paths on Mathematical Reasoning Skills

Evaluating the impact of implementing Gamification-Based Learning Paths (GLPs) on mathematical reasoning skills requires a comprehensive approach through a combination of quantitative and qualitative methods. GLPs, as a learning approach that incorporates game elements into the structure of learning paths, are designed to increase student engagement, motivation, and thinking skills in solving mathematical problems. To assess the effectiveness of this strategy, a quantitative evaluation was conducted by measuring scores on improvements in mathematical reasoning skills, while a qualitative evaluation explored the subjective perceptions and experiences of students and teachers during program implementation. The combination of the two provides a comprehensive picture of the pedagogical impact of GLPs in the context of mathematics learning, particularly in classrooms with diverse cultural backgrounds (Ur Rahim & Ali Mohammed, 2024b).

The quantitative method was conducted through pre- and post-test measurements focused on mathematical reasoning skills. These tests were

designed to measure key indicators of reasoning skills, such as the ability to construct valid mathematical arguments, solve non-routine problems, and demonstrate logical thinking patterns in solving math problems. The instruments used included context-based questions with levels of complexity, which encouraged students to explain their steps in writing. The results of these tests were then analyzed statistically, using both a t-test to identify significant differences before and after the implementation of GLPs and a regression analysis to examine the relationship between the level of engagement in GLPs and improvements in reasoning scores. Additionally, other indicators such as work duration, task completion rate, and participation in online discussion forums were included in the quantitative data, complementing the picture of their impact (Attah et al., 2024).

Meanwhile, the qualitative method focused on collecting narrative data through in-depth interviews, classroom observations, and written reflections from students and teachers. From the student perspective, reflections were used to explore how they interpreted the learning experience using GLPs, including whether they felt more motivated, had a better understanding of mathematical concepts, or were more confident in solving problems. Most students stated that the game-like structure of GLPs made learning more engaging and challenging, encouraging them to try different approaches to solving problems. They also reported that the reward and badge system increased their enthusiasm for completing each level. In addition, students from different cultural backgrounds appreciate the presence of visual and narrative elements in GLPs that are inclusive and can represent their diverse identities ("Proposed Educational Program Predicated on Gamification for Teaching Mathematics as Required by TIMSS and Its Effect on Developing Strategic Competence among Fourth-Grade Male Students," 2025).

In their reflections, teachers assessed that GLPs provided more space for students to express their reasoning strategies independently. They noted that students became more open in discussions, more confident in proposing hypotheses, and more active in evaluating their peers' solutions. One teacher reported that the most significant changes occurred in students who were previously passive or lacked confidence in mathematics, but after participating in GLPs, they showed increased confidence in expressing their opinions. In direct classroom observations, teachers also observed an improvement in the quality of group discussions, with students more frequently supporting their arguments with logical reasoning and using appropriate mathematical

language. This suggests that GLPs not only develop individual skills but also strengthen mathematical collaboration and communication among students.

The evaluation also highlighted several challenges in implementing GLPs, particularly regarding students' initial adaptation to the new, more digitally structured learning format that relies on independent exploration. Some students needed time to become accustomed to the interface and game rules, especially those who had no prior experience with technology-based learning models (Incikabi et al., 2022). However, after the adaptation phase passed, most students demonstrated increased motivation and independence in learning. Teachers also noted the need for additional training to understand the analytical features of the GLPs platform so they could more effectively monitor and provide appropriate interventions for students' reasoning development. Nevertheless, teachers agreed that GLPs were able to address the challenges of differentiated learning in multicultural classrooms by providing personalized space tailored to students' learning styles and cultural backgrounds.

Overall, the evaluation results indicated that the use of GLPs positively contributed to strengthening students' mathematical reasoning skills, particularly in constructing arguments, solving complex problems, and thinking logically. This improvement was evident not only in academic achievement but also in changes in learning behaviors, leading to more active, collaborative, and reflective learning. Both students and teachers responded positively to the effectiveness of this approach, although they acknowledged the need for continued improvement in technical and pedagogical aspects. GLPs have demonstrated their potential as an innovative strategy capable of bridging cultural diversity in the classroom and optimizing mathematical thinking skills through a fun, challenging, and meaningful approach.

Challenges and Solutions for Implementing Gamification-Based Learning Paths in Multicultural Classrooms

Implementing Gamification-Based Learning Paths in multicultural classrooms presents complex challenges but also opens up innovative opportunities in education. Multicultural classrooms are learning spaces inhabited by students from diverse cultural backgrounds, languages, and educational experiences. In such a context, implementing Gamification-Based Learning Paths (GLPs) is not only about designing engaging game-based learning activities, but also encompasses efforts to create learning pathways that are inclusive, equitable, and able to accommodate student diversity. One

of the main challenges in implementing Gamification-Based Learning Paths (GLPs) in multicultural classrooms is the intertwining and mutually reinforcing technical, linguistic, and cultural barriers. Technical barriers include the unequal availability of devices, internet connections, and students' digital literacy (Laksanasut, 2025). Some students may be accustomed to using technology in their learning activities, while others still face difficulties accessing and operating digital devices. This inequality can widen the gap in participation and learning outcomes, especially if GLPs are designed without considering the needs of students with limited access to or proficiency in technology. In addition to technical barriers, linguistic challenges are also a significant concern when implementing GLPs in multicultural classrooms.

The language of instruction used in GLP platforms often refers to a single dominant language, which is not always understandable to all students. Students with different mother tongues may have difficulty understanding the instructions, game narratives, and reward mechanisms offered in GLPs. This lack of understanding not only hinders learning but can also trigger feelings of isolation or a lack of confidence among students who feel unable to keep up with the pace of the game. Cultural challenges, on the other hand, include differences in values, symbols, and forms of communication that may be reflected in the content or structure of GLPs. Visual elements, characters, or storylines in games originating from one culture may be irrelevant or even insensitive to students from other cultures. This risks creating cultural bias or symbolic exclusion, which can indirectly reduce students' motivation to actively engage in the learning process.

In addressing these challenges, teacher training plays a crucial role. Teachers, as learning facilitators, need to be competent not only in the use of technology but also in designing contextual and inclusive gamification-based pedagogies. Teacher training should include an understanding of the principles of GLPs, the ability to identify diverse student learning needs, and strategies for adapting content appropriate to multicultural contexts. Teachers need to be trained to be GLP designers and managers capable of integrating game elements with pedagogical approaches sensitive to student diversity. Furthermore, this training should emphasize the importance of collaboration between educators, the development of multilingual materials, and the integration of local and global cultures into game narratives. Thus, teachers not only play a technical role but also become agents of educational transformation that promotes equity and diversity.

Another solution to consider in implementing GLPs in multicultural classrooms is developing strategies to ensure the inclusivity and engagement of all students. Inclusivity here means not only providing equal access to all students but also ensuring that each student feels represented, valued, and involved in the learning process. One approach that can be implemented is universal design for learning (UDL), a learning design framework that is flexible and responsive to the diverse needs of students. In the context of GLPs, UDL can be realized by providing choices in how students access information, demonstrate understanding, and stay motivated. For example, providing narrative text in multiple languages, using universal visual symbols, or developing a reward system that recognizes various forms of learning achievement, not just cognitive aspects but also participatory and collaborative ones (Bizota & Papadopoulou, n.d.).

Student engagement can also be enhanced by involving them in the GLP design process. Students can be involved in determining the game's theme, selecting characters or storylines, and establishing challenges that align with their interests and backgrounds. By providing space for student voice, GLPs become not only learning tools but also empowering media that build a sense of ownership and responsibility for their own learning process. Furthermore, it is important to create a reflective space within GLPs that allows students to reflect on the cultural values embedded in the game and compare them with their own culture. This not only fosters cross-cultural awareness but also strengthens critical thinking skills and intercultural empathy.

The implementation of Gamification-Based Learning Paths (GLPs) in multicultural classrooms also requires support from the education system as a whole. Education policies must support the use of inclusive and adaptive learning technology. Furthermore, collaboration with educational technology developers who are culturally sensitive and committed to equitable education is crucial. GLPs cannot stand alone as a learning solution; they require an educational ecosystem that is open to innovation and sensitive to the challenges faced by students from diverse backgrounds. In this context, the involvement of parents and local communities is also crucial to ensure that the values espoused in GLPs align with the values internalized within the students' environment. Collaboration between teachers, students, parents, and technology developers will create a synergy that enables GLPs to become effective, enjoyable, and meaningful learning tools for all parties involved.

By understanding and anticipating potential challenges and actively designing inclusive and adaptive solutions, implementing Gamification-Based Learning

Paths (GLPs) in multicultural classrooms can be a transformative strategy in education. GLPs have the potential not only to increase students' motivation and learning skills but also to strengthen cultural awareness, cross-cultural collaboration, and appreciation for diversity. The key to success lies in the willingness to continuously evaluate and adapt GLP designs to the dynamic and heterogeneous realities of the classroom. In an era of evolving globalization and digitalization, the ability to build inclusive and responsive learning spaces to diversity is a key foundation for equitable, relevant, and sustainable education.

CONCLUSION

The conclusion of this study indicates that the implementation of a gamification-based learning paths approach has significant potential for improving students' mathematical reasoning skills in multicultural classrooms. By integrating game elements into the learning process, students from diverse cultural backgrounds can experience more inclusive, interactive, and enjoyable learning. This strategy can bridge cultural differences by creating a learning environment that encourages active participation, collaboration, and contextual exploration of mathematical concepts.

Furthermore, gamification not only increases students' intrinsic motivation but also provides a structured and adaptive learning path, allowing students to progress at their own pace and learning style. In the context of a multicultural classroom, this advantage is crucial because it helps reduce gaps in understanding caused by differences in language, social norms, and diverse learning approaches. Thus, the use of gamified learning paths is a responsive pedagogical solution to the challenges of diversity in the classroom.

Finally, the effectiveness of this approach depends heavily on careful instructional design that is sensitive to cultural dimensions. Teachers need to be competent in designing game-based learning experiences that are not only engaging but also reflect the values of inclusivity and equity. For this reason, collaboration between educational technology developers, educators, and cultural experts is essential to create a mathematics learning model that is able to answer the challenges of educational globalization and the needs of the 21st century generation.

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