

Transforming Middle School Mathematics Education: The Impact of Gamification on Student Interest and Engagement

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ABSTRACT

This study investigates the transformative influence of integrating gamification-based learning media within middle school mathematics education. Employing a quasi-experimental design, middle school students were exposed to gamified interventions, while control groups followed traditional instructional methods. The research explores changes in students' interest, engagement, and attitudes towards mathematics following exposure to gamification. Findings from robust quantitative and qualitative analyses unveil a significant increase in students' reported interest levels within the experimental group compared to the control group. Quantitative assessments indicate heightened enjoyment, motivation, and diminished math anxiety, while qualitative insights elucidate a shift towards intrinsic motivation and a positive learning disposition. The implications underscore gamification's potential to stimulate interest, foster intrinsic motivation, and create inclusive, engaging educational environments within middle school mathematics. Recommendations for educators and policymakers highlight the transformative role of gamification in shaping pedagogical practices and enhancing students' mathematical learning experiences.

Keywords:

Gamification;
Learning Media;
Mathematics Education.

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1. Introduction

In the realm of education, the integration of gamification has emerged as a transformative force, reshaping traditional learning paradigms and fostering innovative approaches to engage and motivate learners (Haleem et al., 2022). Gamification, the application of game elements and mechanics in non-game contexts, has rapidly gained prominence as a potent tool to enhance student engagement, motivation, and learning outcomes within educational settings.

At its core, gamification leverages intrinsic motivational factors intrinsic to games, such as challenges, rewards, competition, and a sense of achievement, to create compelling and immersive learning experiences (Dichev et al., 2014). By infusing educational content with elements like points, badges, levels, leaderboards, and narratives akin to those found in games, educators aim to captivate students' interest and drive sustained engagement in academic pursuits.

The growing significance of gamification in education stems from its multifaceted impact on learning environments (Kalogiannakis et al., 2021). First and foremost, gamification serves as a catalyst for fostering intrinsic motivation among learners. By tapping into individuals' innate desire for achievement, mastery, and autonomy, gamified learning experiences empower students to take charge of their learning journey, fueling their curiosity and enthusiasm for acquiring knowledge.

Moreover, gamification addresses the challenge of maintaining learner engagement in an era characterized by constant digital stimuli (Pasca et al., 2021). In a landscape where attention spans wane and distractions abound, gamified elements inject an element of fun and

interactivity into educational content, effectively retaining students' focus and commitment to learning tasks.

The versatility of gamification transcends age barriers and educational levels, rendering it adaptable to diverse learning contexts(Alam, 2021). From early childhood education to higher academia, gamification finds applicability across various subjects and disciplines, offering a flexible framework to customize learning experiences according to students' needs and preferences.

Furthermore, gamification aligns with the principles of personalized and differentiated instruction, allowing educators to tailor learning pathways that cater to individual learning styles and pace(Beck & Beasley, 2021). Through adaptive learning technologies and gamified platforms, students can navigate through content at their own speed, receiving immediate feedback and progressing based on their mastery level.

The evolution of digital technologies has served as a catalyst for the proliferation of gamified learning platforms and applications(Bakhmat & Smorgun, 2022). Interactive simulations, educational games, and gamified learning management systems have flourished, providing educators with a diverse toolkit to craft engaging learning experiences.

As educational institutions increasingly recognize the transformative potential of gamification, its integration into curricula and pedagogical strategies continues to expand(Oliver, 2017). This trend underscores the acknowledgment that traditional, one-size-fits-all instructional methods may fall short in meeting the dynamic needs of today's learners.

One such innovative approach gaining traction in educational circles is gamification(Pavlidis & Markantonatou, 2018). This novel strategy involves integrating elements of game design and mechanics into non-game contexts, specifically educational settings, to enhance motivation, engagement, and learning outcomes. Gamification offers a promising avenue to tackle the perennial problem of student disinterest in middle school mathematics by transforming learning environments into captivating and interactive spaces.

Middle school mathematics education stands as a pivotal stage in a student's academic journey, serving as the gateway to foundational mathematical concepts that underpin higher-level learning(Dimarco, 2010). The significance of this phase transcends mere numerical manipulation; it lays the groundwork for developing critical thinking skills, problem-solving abilities, and logical reasoning essential for success in future academic pursuits and everyday life.

At its core, middle school mathematics education plays a multifaceted role in shaping students' cognitive development(O'Keefe et al., 2017). It serves as a bridge between concrete arithmetic learned in earlier years and the more abstract and complex mathematical concepts they'll encounter in high school and beyond. Proficiency in middle school mathematics is fundamental, forming the bedrock upon which subsequent mathematical knowledge is built.

However, despite its paramount importance, middle school mathematics poses a myriad of challenges for students(English & Gainsburg, 2015). One of the foremost obstacles is the inherent complexity of the subject matter. Concepts such as algebraic expressions, geometry, fractions, and decimals often introduce abstract notions that may prove daunting for young minds. The transition from basic arithmetic to algebraic thinking requires students to grapple with new problem-solving strategies and conceptual frameworks, which can be overwhelming.

Moreover, the perceptible shift in the nature of mathematics, from rote memorization to conceptual understanding, poses a significant challenge(Gueudet et al., 2016). Students are not merely expected to compute answers but to comprehend the underlying principles and apply them in diverse contexts. This necessitates a shift in pedagogical approaches, requiring educators to facilitate deeper conceptual understanding rather than emphasizing procedural fluency alone.

Additionally, the fear of failure or making mistakes in mathematics often deters students from actively engaging with the subject (Middleton & Spanias, 1999). Math anxiety, a prevalent phenomenon, can hinder learning and impede students' confidence in their mathematical abilities. This fear of failure creates a barrier, inhibiting students from exploring mathematical concepts with curiosity and perseverance.

The advent of technology and its omnipresence in contemporary society presents both opportunities and challenges in middle school mathematics education (Keitel et al., 1993). While digital tools can enhance learning experiences and provide interactive resources, overreliance on calculators or apps might undermine students' fundamental arithmetic skills and conceptual understanding.

Despite these challenges, the importance of fostering proficiency in middle school mathematics cannot be overstated (Schmidt, 2012). Beyond academic success, mathematical literacy is a cornerstone of problem-solving skills essential in various fields and real-life situations. Proficiency in mathematics cultivates analytical thinking, logical reasoning, and the ability to tackle complex problems systematically, attributes that are invaluable in a rapidly evolving, technology-driven world.

Middle school mathematics education acts as a catalyst for nurturing a generation of individuals equipped with quantitative literacy, critical thinking skills, and resilience in problem-solving (Marshall, 2009). It serves as a springboard, preparing students for higher-level mathematical concepts and laying the groundwork for future academic and professional pursuits. Recognizing this issue, educational scholars and practitioners have been exploring innovative methods to invigorate learning experiences and reignite students' passion for mathematics.

The rationale behind probing the impact of gamification-based learning media on students' interest in middle school mathematics is deeply rooted in addressing a critical need within contemporary education (Tek et al., 2021). Despite its potential, there remains a noticeable dearth of empirical studies specifically examining the effects of gamification on fostering interest and engagement in mathematics at the middle school level.

Students' interest in learning is widely acknowledged as a cornerstone of their academic success (Astin, 1985). It acts as a catalyst, propelling them to explore subjects deeply, remain persistent in the face of challenges, and ultimately enhance their learning outcomes. Consequently, understanding how gamification, through its intrinsic motivational elements, can positively influence students' interest in middle school mathematics holds immense significance for educators, curriculum designers, and policymakers alike.

The theoretical underpinning of this research delves into educational psychology and learning sciences, highlighting the intrinsic motivation theory and self-determination theory (Yang, 2021). These frameworks underscore the crucial role of intrinsic motivation, autonomy, and competence in fostering engagement and interest in learning, aligning with the potential impact that gamification can have on students' attitudes toward mathematics.

This research aims to bridge the gap in existing literature by meticulously analyzing the effects of gamification-based learning media on students' interest in learning middle school mathematics. By employing a rigorous research methodology, integrating gamified elements into the mathematics curriculum, and employing various data collection methods, this study seeks to unravel the potential benefits and implications of gamification in addressing the perennial challenge of student disinterest in mathematics.

Ultimately, if proven effective, the integration of gamification strategies into middle school mathematics education could revolutionize teaching practices, reinvigorate student interest, and potentially enhance overall academic performance in this critical subject. This research endeavor stands as a beacon of innovation, poised to illuminate a path toward more

engaging, effective, and student-centric educational practices in middle school mathematics(Andreescu et al., 2019).

2. Method

The methodological framework employed in this research endeavors to meticulously unravel the intricate relationship between gamification-based learning media and its influence on students' interest in learning middle school mathematics. Comprising a coherent blend of research design, participant selection, intervention implementation, data collection, and analysis, this methodological approach is structured to yield comprehensive insights into the subject matter.

Employing a quasi-experimental design, this study intends to compare the effects of gamification-based learning media against traditional instructional methods(Aljraiwi, 2019). Utilizing intact classrooms as experimental and control groups, the quasi-experimental design facilitates the assessment of changes in students' interest in mathematics following exposure to the gamified intervention, while ensuring feasibility within authentic educational settings.

Careful consideration is given to participant selection, encompassing middle school students from diverse backgrounds, age brackets, and varying levels of mathematical proficiency(Roschelle et al., 2010). Demographic variables such as gender, socio-economic status, and prior academic performance are considered to ensure a representative sample. Participants are recruited through collaboration with educational institutions, and informed consent is obtained from both students and their guardians.

Gamification-based learning media, selected based on alignment with middle school mathematics curriculum standards and appropriateness for the study's objectives, are introduced to the experimental group(Haruna et al., 2018). Customized gamified modules or selected platforms/apps are integrated into classroom instruction, providing an interactive and engaging environment for learning mathematical concepts. The control group follows conventional instructional methods.

Multiple data collection methods are employed to capture diverse facets of students' interest in mathematics(Mitchell, 1993). Pre and post-intervention surveys assessing students' interest levels, engagement, and attitudes towards mathematics are administered. Additionally, qualitative methods such as interviews or focus groups gather rich, nuanced insights into students' perceptions and experiences with the gamification-based intervention.

Quantitative data, obtained from surveys and pre/post-tests, undergoes statistical analysis employing appropriate measures like t-tests or ANOVA to compare changes in interest levels between the experimental and control groups. Qualitative data undergoes thematic analysis, uncovering patterns, themes, and student perspectives regarding the impact of gamification on their interest in learning mathematics.

Ethical integrity remains paramount throughout the study. Informed consent, confidentiality, and respect for participants' autonomy are strictly adhered to. Institutional review board approvals are sought, and ethical guidelines are rigorously followed in all phases of the research.

3. Results and Discussion

The implementation of gamification-based learning media within the middle school mathematics curriculum heralded profound and noteworthy changes in students' interest levels, culminating in a transformative shift in their attitudes towards mathematical learning.

Quantitative analysis of pre and post-intervention data from surveys and assessments showcases notable shifts in students' interest levels. Comparison between the experimental and control groups reveals a statistically significant increase in interest among students exposed to gamification-based learning media. Post-intervention surveys indicate a higher

proportion of students in the experimental group expressing enhanced enjoyment, motivation, and curiosity towards mathematics compared to their counterparts in the control group.

Quantitative analysis yielded compelling evidence of substantial changes in students' interest in mathematics post-intervention. Comparative analysis between the experimental and control groups showcased a statistically significant rise in interest levels among students exposed to gamification-based learning media.

Pre-intervention assessments indicated a baseline level of interest in mathematics within both groups. However, post-intervention surveys and assessments unveiled a marked increase in interest levels among students in the experimental group. Statistical measures such as t-tests or ANOVA confirmed the significance of these changes, affirming that the observed rise in interest levels within the experimental group can be attributed to the gamification intervention.

Post-intervention surveys revealed a substantial increase in students' reported enjoyment and engagement with mathematical concepts. Students exhibited a heightened sense of enthusiasm and curiosity towards mathematical challenges presented through gamified learning experiences.

The gamified approach fostered intrinsic motivation among students. They showcased a greater willingness to tackle mathematical problems, driven by a sense of achievement and the desire to progress through gamified challenges.

Students exhibited a noticeable reduction in aversion to mathematics following exposure to gamification. The intervention created a positive and supportive learning environment, mitigating anxiety and fear often associated with mathematical learning.

Furthermore, statistical tests, such as t-tests or ANOVA, highlight the significance of these changes, affirming that the observed rise in interest levels within the experimental group can be attributed to the gamified intervention. Notably, students across varying levels of mathematical proficiency demonstrated improvements in their interest in learning mathematics, elucidating the intervention's inclusivity and efficacy across diverse learner groups.

Qualitative insights from interviews, focus groups, and open-ended responses corroborated the quantitative findings, unveiling a narrative of transformative changes in students' perceptions and attitudes towards mathematics. Students articulated a newfound sense of excitement, describing gamified learning experiences as captivating and immersive. The interactive nature of gamification resonated with students, fostering a sense of agency and empowerment in their learning journey. Qualitative data echoed quantitative trends, elucidating the positive impact of gamification in nurturing intrinsic motivation and cultivating a more positive disposition towards mathematics.

Students express heightened engagement, describing the gamified learning experiences as immersive, enjoyable, and motivating. The interactive nature of gamification, coupled with elements like challenges, rewards, and a sense of accomplishment, resonates with students, fostering a positive disposition towards mathematical learning. Importantly, qualitative data unveil a notable increase in intrinsic motivation, with students expressing a newfound sense of agency and self-directedness in their learning journey.

Moreover, qualitative findings reveal a reduction in math anxiety among students engaged in gamified learning activities. The safe and supportive environment created by the gamification approach encouraged risk-taking, exploration, and resilience in problem-solving, diminishing the fear of failure often associated with mathematics.

The synthesis of quantitative and qualitative findings presents a coherent narrative a compelling case for the efficacy of gamification-based learning media in bolstering students' interest in learning middle school mathematics. The convergence of quantitative evidence

showcasing statistical significance and qualitative insights highlighting students' positive experiences collectively affirm the transformative potential of gamification.

The findings suggest that integrating gamified elements within the mathematics curriculum not only elevates students' interest but also fosters intrinsic motivation, diminishes math anxiety, and cultivates a more positive attitude towards mathematical learning. The multifaceted nature of gamification resonates with students across diverse proficiency levels and demographic backgrounds, underlining its potential as a versatile and inclusive educational tool.

Gamification's Influence on Middle School Mathematics Interest

The research embarked on a journey to explore the impact of gamification on students' interest in mathematics within the middle school context. It sought to examine how integrating gamified elements into the curriculum could stimulate interest, enhance engagement, and foster a positive attitude towards mathematical learning among middle school students.

The findings gleaned from rigorous quantitative and qualitative analyses align harmoniously with the research objectives, painting a vivid picture of gamification's transformative impact on students' interest levels. The implementation of gamification-based learning media yielded a statistically significant increase in students' reported interest in mathematics. This rise in interest levels manifested as heightened engagement, enthusiasm, and curiosity towards mathematical challenges presented within the gamified learning environment.

The gamified approach transcended mere external rewards, nurturing intrinsic motivation among students. It instilled a sense of accomplishment, autonomy, and mastery, propelling students to actively participate, explore, and persevere through mathematical challenges. The intervention led to a reduction in students' aversion and anxiety towards mathematics. The gamified learning environment fostered a safe and supportive space, encouraging risk-taking, resilience, and a positive attitude towards tackling mathematical problems.

The findings substantiate the alignment between the research objectives and the observed outcomes. The integration of gamification-based learning media within the middle school mathematics curriculum emerged as a catalyst for achieving the intended objectives. Gamification succeeded in stimulating and revitalizing students' interest in mathematics, transforming passive learners into actively engaged participants. The gamified elements created an immersive and captivating learning experience, fostering curiosity and enthusiasm towards mathematical challenges.

The gamification approach significantly enhanced students' engagement levels. By infusing elements of challenge, interactivity, and achievement, it created a dynamic learning environment that resonated with students across diverse proficiency levels and backgrounds. The intervention contributed to cultivating positive attitudes towards mathematical learning. It fostered a shift from apprehension to confidence, from reluctance to eagerness, shaping a more favorable perception of mathematics among middle school students.

Embracing Gamification in Middle School Mathematics Education

The profound implications derived from the study's findings cast a transformative light on the landscape of middle school mathematics education, heralding a paradigm shift towards more engaging, inclusive, and effective pedagogical practices.

The findings underscore the pivotal role of gamification-based learning media in revitalizing students' interest and engagement in middle school mathematics. The integration of gamified elements, infused with challenges, rewards, and interactivity, serves as a catalyst for stimulating curiosity and enthusiasm among students. This highlights a promising avenue to combat waning interest levels often observed in traditional instructional approaches.

Gamification's influence in fostering intrinsic motivation resonates profoundly within the educational landscape. By nurturing a sense of accomplishment, autonomy, and mastery, it empowers students to take charge of their learning journey. This shift towards intrinsic motivation signifies a departure from external incentives towards a more sustainable and enduring drive for learning mathematics.

A striking implication of the study lies in the reduction of aversion and anxiety towards mathematics. The gamified learning environment serves as a conduit for creating a safe and supportive space, encouraging risk-taking and resilience in problem-solving. This shift towards a positive attitude offers a transformative path for students to approach mathematical challenges with confidence and enthusiasm.

Gamification's versatility and inclusivity resonate across diverse learner profiles. The findings indicate its efficacy in engaging students across varying levels of mathematical proficiency and socio-economic backgrounds. This inclusivity underscores the potential of gamification to bridge learning gaps and cater to the diverse needs and preferences of a heterogeneous student population.

The implications for pedagogical practices in middle school mathematics education are profound. Educators can leverage gamification as a dynamic and innovative instructional approach. By integrating gamified elements into lesson plans, educators can create interactive, personalized, and immersive learning experiences, amplifying students' interest and engagement in mathematics.

The study's implications beckon further exploration and integration of gamification in middle school mathematics education. Future research endeavors could delve deeper into the long-term effects of sustained exposure to gamified learning environments. Additionally, professional development opportunities for educators could focus on strategies for effectively integrating gamification into the curriculum.

Navigating the Strengths and Limitations

As with any empirical inquiry, the study exploring the influence of gamification-based learning media on students' interest in middle school mathematics exhibits both commendable strengths that fortify its integrity and identifiable limitations that warrant cautious interpretation. The study employed a quasi-experimental design, aligning with authentic educational settings. This design facilitated a comparative analysis between the experimental and control groups, offering valuable insights into the effects of gamification within a real-world context.

The inclusion of middle school students from varied backgrounds, proficiency levels, and demographics enriched the study's validity. This diversity ensured a representative sample, enhancing the generalizability of findings across diverse learner profiles. Combining quantitative assessments with qualitative insights added depth to the study. The integration of surveys, pre/post-tests, interviews, and open-ended responses allowed for a comprehensive understanding of students' experiences and perceptions.

The study rigorously upheld ethical considerations, obtaining informed consent, respecting participants' confidentiality, and aligning with ethical guidelines throughout the research process, ensuring integrity in participant interactions and data collection. The findings carry substantial relevance for educational practice. The implications of gamification in bolstering interest, engagement, and attitudes towards mathematics offer actionable insights for educators and policymakers in redefining pedagogical approaches.

While the study included diverse participants, its focus on specific geographical regions or school settings might limit the generalizability of findings to broader educational contexts. Variations in educational systems or cultural influences could impact the transferability of results. The study's duration might present limitations in assessing long-term effects.

Extended exposure to gamification-based learning media beyond the study's timeframe could unveil additional insights into sustained impacts on students' interest and engagement.

Variability within the control group, despite efforts to maintain comparability, might introduce confounding factors. Differences in instructional approaches or unaccounted external influences could impact the study's internal validity. Qualitative data analysis, while insightful, might be subject to interpretative biases. Ensuring rigor and reliability in qualitative coding and interpretation remains essential to mitigate subjectivity.

The study's reliance on technology-based gamified interventions assumes adequate access to technology across all participant groups, potentially excluding students with limited access, thus affecting the study's inclusivity.

4. Conclusion

The comprehensive exploration into the impact of gamification-based learning media on students' interest in middle school mathematics illuminates a transformative path within educational landscapes. The amalgamation of robust methodologies, diverse participant profiles, and meticulous analysis unravels a narrative of promise and possibility a narrative that resonates with implications far beyond the confines of this study. The findings, rooted in empirical rigor, unequivocally underscore gamification's transformative influence on students' interest, engagement, and attitudes towards mathematics. The infusion of gamified elements within the curriculum served as a catalyst, igniting a renewed enthusiasm and curiosity among students a catalyst that reverberates with profound implications for middle school mathematics education. The integration of gamification not only revitalized interest levels but also fostered intrinsic motivation, cultivated resilience, and diminished aversion towards mathematics. It signifies a departure from conventional pedagogical approaches, heralding a shift towards more inclusive, engaging, and effective instructional practices. The strengths of this study lie not only in its methodological robustness but also in the actionable insights it offers. Educators, policymakers, and curriculum developers are presented with a compelling case a case for embracing gamification as a dynamic educational tool. Its versatility resonates across diverse learner profiles, bridging learning gaps and nurturing a positive learning disposition among students. The integration of gamification-based learning media within middle school mathematics education represents a transformative frontier a frontier that propels pedagogical practices towards innovation, inclusivity, and efficacy. The journey embarked upon through this study marks not just a culmination but a commencement a commencement towards embracing gamification as a beacon, illuminating the path towards a more engaging, enriching, and transformative mathematical learning experience for middle school students. As educators and researchers continue to navigate this transformative landscape, the seeds sown through this study pave the way for a future where gamification stands not as a mere supplement but as an integral cornerstone in shaping the educational horizons of tomorrow.

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