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Wordwall-Based Gamification to Improve Understanding of the Demand Function: A Madrasah Aliyah Case Study

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Abstract
Understanding the concept of the demand function in economic mathematics is still a challenge for Madrasah Aliyah students due to the abstract and applicative nature of the material. This study aims to analyze the effectiveness of gamification using the Wordwall platform in improving students' understanding of the demand function concept at MAS At-Taqwa Beru. This study uses a qualitative approach with a case study design involving 30 eleventh-grade students selected through purposive sampling. Data were collected through participatory observation, semi-structured interviews, and documentation, and analyzed thematically. The results showed an increase in active student participation from 55% to 80% during gamification learning and an increase in the average learning score from 62.3 to 78.5 (gain ±26%). Wordwall facilitated students' understanding through interactive visualization and contextual questions, stimulated intrinsic motivation, and encouraged collaboration among students. These findings support social constructivism theory and Self-Determination Theory that interaction, autonomy, and instant feedback are important in building conceptual understanding. Theoretically, this research enriches the literature on gamification in economics learning at the Madrasah level, while practically recommending the integration of Wordwall as an effective alternative learning medium, supported by digital facilities and school policies so that its implementation can be carried out systematically and sustainably.

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Introduction

In the 21st century, education must evolve to equip learners with critical, creative, collaborative, and communicative thinking skills, which are essential for navigating the complexities of the digital and global world (Əliyev 2024). The integration of digital tools and platforms enhances collaborative learning, enabling students to adapt to rapid technological changes while also emphasizing the importance of economic and mathematical literacy for data-driven decision-making (- 2023; Ismuni, Usman, and Choiriyah 2024). The report by the Organization for Economic Cooperation and Development (OECD) (2020) highlights a concerning trend in which only a small proportion of students worldwide achieve high competency in mathematics, a situation that can be addressed through the integration of digital technology in education, as emphasized by the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2018). Research shows that digital technology significantly enhances mathematics learning by fostering interactivity and improving conceptual understanding, which is crucial for developing problem-solving and logical reasoning skills (Anon 2023; Ardyan 2024). Dynamic interactive software facilitates visualization and connects multiple representations, thereby enriching the learning experience (Dockendorff 2020).

The results of the Programme for International Student Assessment (PISA) 2018 indicate the low mathematics proficiency of Indonesian students, with 71% of learners experiencing difficulties in applying mathematical concepts to contextual problem-solving(Wijayanti and Nalurita 2024). This condition is also evident in Madrasah Aliyah-based educational institutions, particularly in the teaching of economics-related mathematics. This poor performance is linked to various factors, including a traditional education system that emphasizes rote learning and insufficient teacher training (Manggala and Yuniawatika 2021; Nandang Mustafa 2023). The Merdeka Belajar policy of the Ministry of Education aims to improve numeracy literacy and integrate technology into learning, addressing these shortcomings by promoting active teaching methods and context-based problem-solving approaches(Nandang Mustafa 2023; Satiti, -, and Khotimah 2021). Research shows that errors in understanding and transformation are prevalent among students, highlighting the need for enhanced instructional strategies that foster deeper comprehension and the application of mathematical concepts in real-life scenarios (Satiti et al. 2021)

Education serves as a crucial foundation for developing students' skills, particularly in understanding complex economic mathematics concepts such as the demand function. The integration of innovative learning methods, such as interactive games and simulations, has been proven to improve financial literacy and practical skills among students, fostering a deeper understanding of financial principles (Kalashnikov et al. 2024). The low level of student autonomy in learning specialized mathematics occurs due to the lack of variety in learning media used for delivering material and assessments (Ayu, Anomeisa, and Ndori 2023). This presents a serious challenge in the teaching of economic mathematics, where many students struggle to understand the relationship between concepts, graphs, and real-world applications.

Mathematics serves as the backbone of economics, providing a precise framework for analyzing and solving economic problems through models such as the supply and demand model(Kumar 2024). By utilizing these innovative strategies, educators can create a more enjoyable and efficient learning environment that not only enhances students' analytical skills

but also prepares them to face real-world economic challenges (Kumar 2024; Thi Phuong Thao 2024). One innovative learning approach currently trending in the field of education is gamification-based learning.

Gamification, which applies game design elements to educational contexts, significantly enhances student engagement and motivation by creating immersive learning experiences that foster competition and achievement (Gorai 2024; Kara and Russell 2024). This approach not only cultivates critical thinking and problem-solving skills but also aligns with the demands of modern education for innovative teaching strategies that improve learning outcomes (Husnutdinov and Gilmanov 2024; De Oliveira and Antonio Sichieri 2025). By leveraging this method, educators can better prepare students for real-world challenges, ultimately increasing their readiness for the labor market. The integration of technology, such as interactive software and online platforms, plays a crucial role in creating an active and adaptive learning environment.

One of the prominent gamification platforms is Wordwall. As an interactive learning tool, Wordwall enables teachers to create educational games in various forms such as quizzes, random wheels, and matching games. For example, in the context of mathematics education, Wordwall is used to design didactic games that actively engage students, demonstrating its potential to transform traditional learning environments into more dynamic and interactive ones (Teófilo de Sousa, Ferreira de Azevedo, and Régis Vieira Alves 2022). Similarly, Wordwall's visually appealing and easily accessible format has been found to foster students' curiosity and enthusiasm for learning, making it an effective tool for achieving learning objectives (Miftakhul Jannah and Eli Masnawati 2024). Wordwall for economic mathematics in Madrasah Aliyah remains underexplored; however, existing studies provide valuable insights into its potential benefits. For instance, Wordwall has been shown to improve students' mathematical representation skills, foster interactive learning environments, and enhance (Salsabila and Tsurayya 2024). In addition, Wordwall edugames have been found to significantly improve students' mathematical problem-solving skills, as evidenced by substantial increases in test scores after its implementation (Putri and Tsurayya 2024).. In the context of economics, Wordwall has also been proven to have a significant impact on learning outcomes, as demonstrated in a study involving economics students, where notable improvements were observed post-intervention (Minarta and Pamungkas 2022). These findings collectively indicate that Wordwall can be a valuable tool in improving students' understanding of economic mathematics concepts, potentially benefiting Madrasah Aliyah by making complex topics such as the demand function more accessible and engaging.

At Madrasah Aliyah Swasta (MAS) At-Taqwa Beru, the teaching of economic mathematics is still dominated by a conventional, teacher-centered approach and has yet to make extensive use of interactive technology. Initial observations indicated low student engagement in learning about the demand function, as well as limited utilization of innovative learning media. Considering the potential of Wordwall in enhancing students' understanding and engagement, this approach is worth examining in depth within the context of Madrasah education. Based on this description, the research problem in this study is: *"How can the use of gamification through Wordwall improve students' understanding of the demand function material at MAS At-Taqwa Beru?"*

The objective of this study is to analyze the use of the Wordwall platform as a form of gamification in improving students' understanding of the demand function material, as well as to evaluate its impact on students' motivation and engagement in the context of economic mathematics.

Method

This study employed a qualitative approach with an intrinsic case study design to gain an in-depth understanding of students' experiences in using Wordwall-based gamification for learning the demand function material at MAS At-Taqwa Beru. The researcher acted as the key instrument, responsible for planning, collecting, analyzing, and interpreting the data, assisted by research instruments in the form of a participatory observation guide, a semi-structured interview guide, and a learning artifact documentation sheet (Wordwall logs, students' work, and classroom interaction recordings). The research subjects consisted of 30 eleventh-grade students selected using heterogeneous purposive sampling based on variations in initial understanding, activeness, and experience with learning technology.Data collection techniques included observation, in-depth interviews with teachers and students, and documentation. Data validity was tested through source and method triangulation, member checking, peer debriefing, and an audit trail by systematically documenting each stage of the research process. Data analysis followed Miles and Huberman's approach, namely: (1) data reduction through transcription and open coding to identify meaning units; (2) data display by grouping codes into main themes; and (3) conclusion drawing/verification to identify thematic patterns regarding the impact of using Wordwall on students' understanding and engagement in learning the demand function.

Results and Discussion

Results

Observation results showed that out of the 30 eleventh-grade students of MAS At-Taqwa Beru who participated in the study, 24 students (80%) were actively engaged during the learning process with Wordwall, as indicated by their participation in games, involvement in class discussions, and prompt responses to problem-solving challenges.

Tabel 1. Comparison of Student Scores :

Category	Average	Standard Deviation
Before Wordwall	62.3	8.4
After Wordwall	78.5	6.9

Quantitatively, the students' average score increased from 62.3 (SD = 8.4) on the pre-test to 78.5 (SD = 6.9) on the post-test after the use of Wordwall, indicating an improvement of 16.2 points or equivalent to a learning gain of approximately 26%. The variation in student scores also narrowed, as shown by the decrease in standard deviation from 8.4 to 6.9, which can be interpreted as both an increase in achievement and a greater consistency in students' understanding. This analysis demonstrates that the use of Wordwall not only impacts learning outcomes positively but also reduces the gap in student abilities.In-depth interviews reinforced

these findings, revealing themes of increased intrinsic motivation and faster cognitive comprehension. One student remarked, *"I find it easier to understand the questions because they feel like a game..."*, while the teacher noted, *"Students who are usually passive became more active and were not afraid to try answering questions."*Documentation from Wordwall logs and students' answer artifacts indicated that they were not only able to answer questions procedurally but also relate them to real-world contexts of the demand function in market economics. These combined findings confirm that the application of Wordwall gamification has a positive cognitive and affective influence on students' understanding of the demand function material.

Discussion

The findings of this study indicate that gamification through the Wordwall platform significantly enhances students' understanding of the demand function material in Grade XI at MAS At-Taqwa Beru. Students' active engagement during the learning process demonstrates that educational game-based media can create a more interactive and enjoyable learning environment. From a social constructivist perspective, such experiential learning provides opportunities for students to actively construct knowledge through interactions with peers and learning materials (Kalashnikov et al. 2024). Wordwall, as a form of gamified media, enables the learning process to be both participatory and reflective, aligning with the principle that students learn better when they are emotionally and cognitively engaged in the process.Furthermore, students' intrinsic motivation appeared to increase during the learning activities, supporting the Self-Determination Theory framework (Ryan and Deci 2000). This theory asserts that learning becomes more effective when it meets three basic psychological needs: autonomy, competence, and relatedness. In the context of Wordwall, autonomy is reflected in students' freedom to choose and complete the games; competence is supported by instant feedback that boosts self-confidence; and relatedness emerges from social interaction during discussions and competitions. This is reinforced by the study (Christopoulos and Mystakidis 2023), which found that gamification positively influences students' perceptions of competence and interest in learning.

Nevertheless, a more critical analysis reveals that the success of Wordwall in improving learning outcomes cannot be separated from the relatively supportive contextual conditions at the madrasah where the study was conducted. The involvement of teachers in guiding the use of technology, the adequate availability of digital devices, and the initial enthusiasm of students toward the new approach may generate a novelty effect—an immediate impact stemming from the newness of the learning experience. This potential bias should be taken into account, considering that such an effect may not persist in the long term or in contexts with less supportive infrastructure.Furthermore, comparisons with other contextual studies in madrasahs indicate that the results are not always consistent. For example, the study by (Sutarsi Suhaeb, Anita Candra Dewi, and Nuridayanti 2024) did find that gamification can enhance students' motivation and learning outcomes, but it did not substantially address aspects of contextual economic understanding as explored in this research. Meanwhile, the study by Maulidah (2023) in another madrasah showed that students unfamiliar with digital media experienced pressure when required to complete time-based games, which in turn reduced

participation. This indicates that the success of gamification-based learning is highly influenced by technological readiness, students' digital literacy, and teacher support in facilitating the learning process.

This study also identified that not all students were able to solve high-order cognitive problems independently. This highlights the importance of designing games that are adaptive to differences in ability. As noted by (Ayu et al. 2023), the lack of variation in media and learning approaches can reduce students' independence in learning economic mathematics. Therefore, the use of Wordwall should be accompanied by scaffolding strategies that enable lower-ability students to remain meaningfully engaged.Documentary evidence from Wordwall logs and students' answer artifacts shows that students were not only able to solve factual problems, but also capable of connecting the concept of the demand function with real-world economic phenomena. This aligns with the report by Kalashnikov et al. (2024), which stated that gamification can help students understand financial principles in practical contexts. Thus, this research contributes new insights to the literature on economics education in madrasah settings, particularly in the use of interactive technology-based learning strategies for complex economic mathematics topics.

Nevertheless, the main limitation of this study lies in its narrow scope (a single madrasah with 30 participants) and the nature of its case study design, which is not intended for broad generalization. Therefore, these results should be understood as a contextual exploration that provides a basis for further research. The researchers also acknowledge the potential bias arising from direct involvement in the learning process, although steps such as triangulation, member checking, and peer debriefing were undertaken to maintain objectivity. Follow-up studies employing quasi-experimental designs or classroom action research across various madrasah settings could enrich these findings while testing the consistency of Wordwall's impact in more diverse contexts. Conceptually, this study reinforces the importance of participatory, contextual, and adaptive learning approaches tailored to learners' characteristics. Teachers can no longer merely act as content deliverers; they must become facilitators who design engaging, challenging, and meaningful learning experiences. In this context, Wordwall is not merely a teaching aid but a medium capable of mediating students' cognitive, affective, and social engagement in learning economic mathematics. Therefore, the integration of such gamification tools should continue to be developed as part of pedagogical innovations in madrasah education to enhance the quality of 21st-century learning.

Conclusion

This study concludes that the use of gamification through the Wordwall platform has proven effective in enhancing students' understanding of the demand function material at MAS At-Taqwa Beru. This is reflected in the increase in students' average scores from 62.3 to 78.5, as well as the rise in active participation to 80% during the learning process. Wordwall stimulated intrinsic motivation, encouraged collaboration, and enriched students' learning experiences both cognitively and affectively, aligning with the social constructivist approach and Self-Determination Theory, which emphasize the importance of active engagement, autonomy, competence, and relatedness in technology-based learning. The practical implication of these findings is that teachers are advised to integrate Wordwall into routine teaching practices as a

medium for formative assessment and interactive concept reinforcement, adjusting the game levels to match students' abilities. At the institutional level, schools/madrasahs need to provide digital infrastructure support and ICT training for teachers so that the use of Wordwall can run optimally and sustainably. From an educational policy perspective, it is recommended that the Ministry of Religious Affairs and education offices include the development of digital gamification competencies (such as Wordwall) in teacher professionalism enhancement programs and in the Digital Madrasah roadmap, ensuring that this innovation is not sporadic but systematically integrated into the economics mathematics curriculum. This study is limited by the small respondent scale and the specific educational context. Therefore, future research is recommended to examine the effectiveness of Wordwall in other economics topics and different madrasah contexts to obtain more generalisable findings and to assess its impact on students' higher-order thinking skills.

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Authors' Note

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