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THE ROLE OF GAMES IN CONTEMPORARY EDUCATION: CHALLENGES FOR THE TEACHERS AND STUDENTS IN THE ERA OF BLENDED LEARNING – CORRELATION BETWEEN GRADES AND GAMES PERFORMANCE

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Abstract: In recent years, there has been a surge in information and communications technology, propelled by the pandemic's emphasis on remote learning. Interactive technologies like computers, tablets, and mobile phones hold promise for digitizing work and education, fostering creativity and immersion. Educators are increasingly exploring the integration of interactive and game-based tools into learning, inspired by the widespread popularity of gaming across age groups. Immersive game-based platforms, capable of integrating curricula and functioning in multiplayer settings, are emerging as a new trend in online learning, offering enhanced engagement for both students and teachers and improving test results. However, integrating games still presents challenges for teachers and students. Understanding the correlation between students' grades and their performance in educational games is a significant challenge. While research suggests that game-based learning can positively impact academic achievement, further exploration is needed to grasp the nuanced relationship between in-game performance and traditional assessment metrics. Formative assessments through game-based solutions have gained popularity, but there is a lack of multiplayer classroom tools offering varied gameplay mechanics and content integration for creative learning. Research into the motivational aspects of multiplayer gaming, the impact of different gameplay dynamics on learning outcomes, and a comparison of multiplayer versus traditional approaches are areas for further exploration. Our study introduces a novel multiplayer game-based platform (Multiplayer Team Training Platform or MTT) addressing the challenges of uniform gameplay, offering a variety of gameplay dynamics and automated tracking of student performance in both single and multiplayer modes. A comparison between traditional assessment and game-based assessment in similar settings was undertaken with different classes, subjects, and age groups, and a comparative study was done to analyze the results of both experiments. The investigations showed that the Control Groups consistently outperformed, suggesting potential benefits of traditional teaching methods, especially under teacher's supervision. However, it was also observed that repeated testing in the control groups did not necessarily result in enhanced retention of knowledge. Conversely, the game-based environment showed gradual improvement with gameplay repetition and reduced concerns about cheating among students. Strong positive correlations between subject grades and performance were found, indicating that higher-graded students excel in both environments, with lower-grade students showing a trend of better and continuous improvement, particularly in the game-based environment.

Keywords: game-based learning, multiplayer learning, quiz game-based assessment
Field: Education

1. INTRODUCTION

The utilization of interactive and game-based tools in education has become a prominent subject among educators in recent times. Contrary to the perception that gaming is solely for the younger generation, recent surveys (TechJury, 2024) indicate that the average age of gamers in 2023 is 34 years old, with 70% of gamers being above 18 years old, and a notable percentage being 65 years and older. 56% of the most frequent gamers play multiplayer games. Additionally, 70% of parents believe that video games have a positive influence.

The primary objective of incorporating gaming into education is to enhance student motivation, engagement, and visual skills, as well as to promote interaction and collaboration among peers. There are multiple studies about its positive outcome (Rivera, 2021; Welbers, K, 2019; Smiderle, R, 2020). While educational technology aims to simplify and enhance learning, its effectiveness in impacting student achievement is contingent upon its alignment with the curriculum (Haleem, A, 2022, p.275-285; Timotheou, S, 2023, p.6695–6726).

Although interactive learning has been shown to yield superior results, there is a misconception that it leads to reduced learning (Deslauriers, L, 2019, p.39; Blume C, 2020). With the widespread adoption of distance learning due to the COVID-19 pandemic, webinar-based tools have become prevalent. While

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they support traditional classroom methods, they also present challenges such as maintaining student focus, attention span, and communication with classmates, alongside technological limitations.

Emerging as a new trend in modern online learning, immersive game-based platforms offer the potential to integrate curricula and operate in multiplayer settings, providing equal engagement for both students and teachers and enhancing test results beyond the gaming environment.

According to Houghton et al. (2013), games entail goals, rules, and voluntary participation from players, serving as tools to support teaching and learning.

They complement traditional learning methods while imparting various skills such as rule-following, adaptation, problem-solving, interaction, critical thinking, creativity, teamwork, and sportsmanship. Repetition remains integral to learning, and gaming offers creative avenues for collaborative or competitive repetition of learned material.

There are multiple platforms for game-based learning like Kahoot, Quizziz, Quizzlet, and others that have proven their effectiveness and motivational impact on learning (Siegle, D. (2015), p.192-197; Wang et al. (2016); Wang & Lieberoth. (2016)). However, these platforms have limitations when it comes to practicing a wide variety of content, such as an entire semester's worth of material. Teachers would need to set up multiple games, each with its own set of questions, making the practical use and efficiency complex. Users would need to log in to different rooms or games each time they want to practice specific content. Additionally, if different gameplay dynamics are desired, teachers would need to use different platforms, each with its own operational rules. This practical inconvenience hinders the usage of such tools for a large amount of learned material.

Our study introduces a novel multiplayer game-based platform that addresses the challenges of uniform gameplay. It offers a variety of gameplay dynamics and automated tracking of student performance in both single and multiplayer modes, all while incorporating the entire content into various gameplay styles. This platform caters to different types of player preferences and varying amounts of triggered questions without requiring teachers to set up individual games or plug the content in different ways. We conducted extensive research into the motivational aspects of multiplayer gaming, the impact of different gameplay dynamics on learning outcomes, and performed a comparison of multiplayer versus traditional approaches.

2. MATERIALS AND METHODS

For this study, we utilized a mixed-methods approach, combining quantitative and qualitative data collection methods, and integrating them for analysis. The experiment consisted of several stages:

1. Quantitative Study:
   - Traditional tests resembling one of the studied games (Time's Up) were conducted to establish comparable conditions between the control (traditional classroom) and game-based approaches.
   - Experiments involved gameplay with custom-designed multiplayer classroom games to assess performance under different dynamics, including single and multiplayer modes.
2. Qualitative Study:
   - Surveys, group discussions and interviews were conducted before and after the experiment to gather insights into user behavior and preferences.

Data collection for the control groups relied on paper-based quizzes and self-evaluation, while the game-based approach utilized an in-game reporting system to measure performance and track progress.

The aim was to evaluate user performance and identify differences between traditional and game-based methods, providing insights into suitable games and parameters for classroom use. The study involved preparation of test materials, participant measurement, and division into Control and Experimental Groups. Tests were conducted within a 5-minute timeframe, with the first 5 trials analyzed. Participants included 4th and 6th-grade students, totaling approximately 65 students across different classes. They were selected to represent diverse demographics and computer literacy levels. The experiment focused on school students, aiming to evaluate the effectiveness of the platform across various demographics and educational contexts.

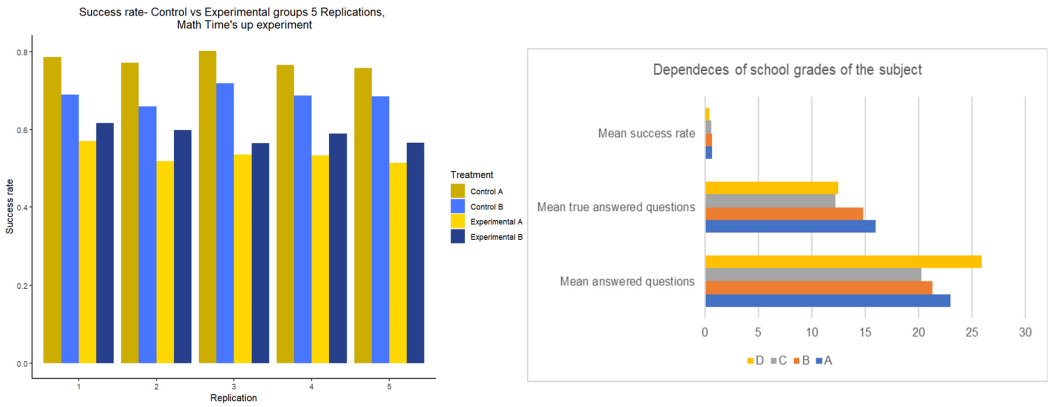
3. RESULTS

In the current study, one of the biggest challenges was accessing high-speed internet during the experiments. The games, being data-cloud dependent, faced connectivity issues, leading students to restart some of the games, potentially decreasing patience and motivation. Additionally, teachers encountered challenges in organizing the ICT infrastructure for the experiment, such as securing enough

mobile devices and computers and finding suitable timing to gather all students without disrupting the regular school environment. Despite these challenges, both teachers and students had a positive experience contributing to this experiment. Both the 4th and 6th grades were divided into classes A and B to facilitate practical implementation.

Results for 4th grade. The descriptive statistics results for the 4th, for both the Control and Experimental Groups, regarding the Mean The success rate for A and B class for the Control and Experimental Groups, are depicted in Fig. 1, together with the descriptive statistics of the results of the 4th grade with regards of their average subject grade.

Fig.1. Descriptive statistics results for 4th grade and results with regards of the student's average subject grades.



Source: Ani Atanasova, data collection is via the MTT platform.

If we compare the results of the Control and Experimental groups, we can notice that for the Control group, the mean success rate is higher than for the Experimental group. This is understandable, as in the Control group, students had the opportunity to see all 100 questions from the test, while in the Experimental group, students can only see one question at a time, and the next question can be answered only if the student has answered the previous one.

Class B exhibits minor variations compared to Class A in the experimental segment, with less differences in the results observed between the control and experimental groups.

The descriptive statistics regarding students' subject grades underscored the significance of their grades on performance, indicating a strong positive correlation between grades and success rates. Higher subject grades corresponded to higher scores in the experiment, emphasizing the importance of academic performance. Additionally, students with lower grades, particularly those with a grade of D, showed a higher mean number of questions but fewer correct answers, suggesting reliance on random responses rather than acquired knowledge.

The data collected is measured repeatedly on the same classes and to trace the effect of treatment on success rate of Math's evaluation ANOVA repeated measures has been performed on R program version 4.2.2. The dependent variable is success rate regressed on the treatment effect with four groups.

ANOVA repeated measures model tests the hypothesis of mean difference among the different groups employing F-test (ref). Therefore, to compare the treatment effect of success rate of the two groups- class A and class B for five repetitions, two ANOVA models have been performed.

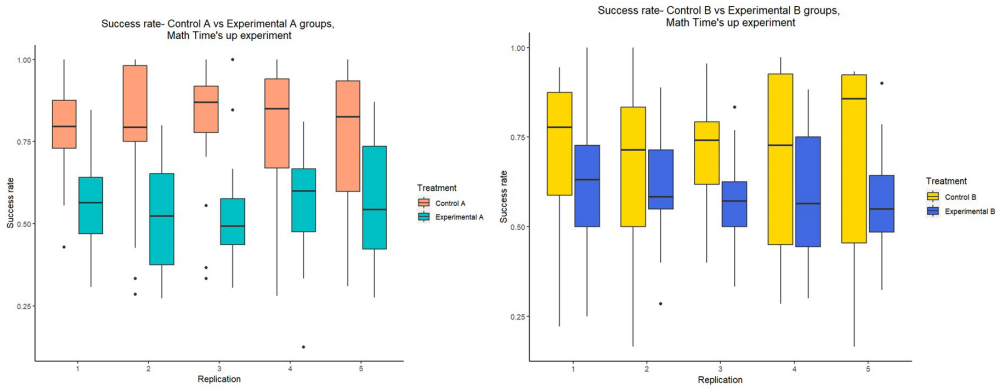
For class A - the most subtle difference of success rate of students in control and experimental state is observed at the third repetition/game with 0.267 mean difference, almost 27%. Looking into the variation in groups. At replication two, five and four experimental group has the greatest variance and overall experimental group experiences greater fluctuations of success rate.

ANOVA results for control B and experimental B show significant results at 95% confidence level in repetition one and two with mean differences 0.07, 0.06 respectively which is positive implying 6-7% greater success rate for Control group than for experimental one in class B. The box plots in Fig.2 show most outliers both in control and experimental group A repetition one to three and experimental B repetitions three to five, as the latter group has only one outlier per repetition. Additionally, control group outpaces the experimental group at every repetition, but the variance here of the control group appears to be higher than that of the experimental one, especially at replication four and five where success rate

oscillates between 0.40-0.90 points. The fifth repetition of the control group demonstrates the highest mean success rate coupled with the highest variation. Oppositely, the experimental group does not show significant difference of success rate between different games except for the fifth repetition in class A and fourth repetition in class B.

Considering that two groups of students performed two differently implemented Math's' evaluation tests simulating the Time's up game, a panel data models should be appropriate to find functional dependence between success rate, number of questions answered and replication number. The panel regression is a powerful model especially when it considers within a group or between-group differences of the subjects, if there are any. On this account, several models have been made to check for such differences and solidify final conclusions.

Fig.2. Boxplots for success rate for 5 replications for students at 4th Grade.



Source: Ani Atanasova, data collection is via the MTT platform.

The first two models of the data collected are constructed for two samples sizes- one of the full sample sizes and one of the students answered more than twenty questions. The dependent variable is the success rate, the independent variables are the number of questions answered, replications, average subject grade and gender.

The analysis revealed that all coefficients of average subject grade are significant for grades C and D in both samples. Specifically, students with a D grade are expected to achieve approximately 12.6% lower success rates compared to those with a C grade, with a slightly lower coefficient of 9.6% for students answering more than 20 questions. Conversely, students with a B grade in Math are expected to obtain success rates around 9.6% and 11.1% higher than those with a C grade, respectively for the smaller sample. Moreover, students with an A grade are anticipated to achieve approximately 12.5% higher success rates compared to those with a C grade in both samples. In conclusion, there is a positive relationship between subject grade and performance, with students with lower grades expected to demonstrate lower success rates.

The analysis for both Class A and Class B, regarding the data of individual students, demonstrated that nearly all negative mean differences in success rates for each student's performances, with one exception in each class, were observed among individuals with a D mark. This suggests that underperforming students and those who struggle in traditional learning environments tend to perform better in gamified settings.

Results for 6th grade. Here like 4th grade, we can observe the same pattern – the mean success rate of the Control Group outbreaks the one for the experimental group – Fig.3. With repeated trials, the control group consistently answered more questions, yet without a corresponding increase in correct responses, highlighting a disparity in knowledge retention. In contrast, the game-based environment demonstrated a smoother progression, with slight improvements in both total and correct answers. It's important to note that the game environment ensures objective scoring, eliminating the possibility of cheating.

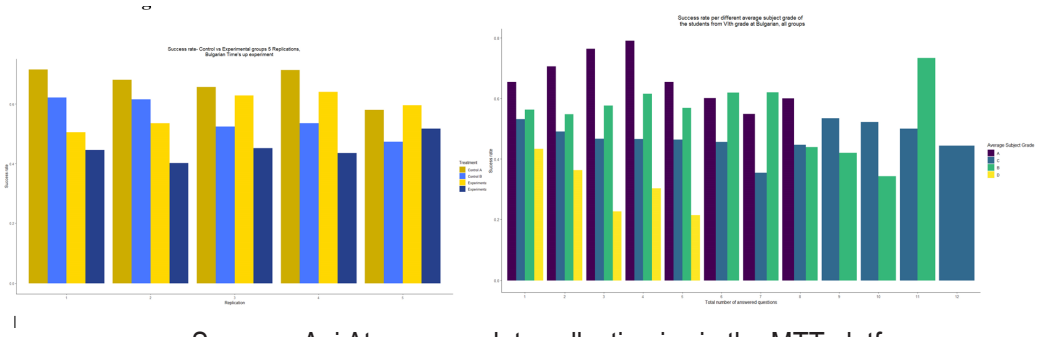
Similar to the results of the 4th grade, it can be observed that the students' grades are positively related to the success rate, as those with excellent marks have the highest mean success rates and total true answers, followed by the very good mark, good, and mediocre.

The box plots for 6th grade, Fig.4, support the evidence in the ANOVA analysis that was done. The highest and most subtle mean difference of success rate between the control and experimental group is in the first and second replication of the experiment.

The same results as in class A are observed in class B. The first and second replication have significant coefficients meaning that the success rate of control and experimental groups differ among the first two replications. For the rest of the trials, there is no statistical proof to show difference in performance.

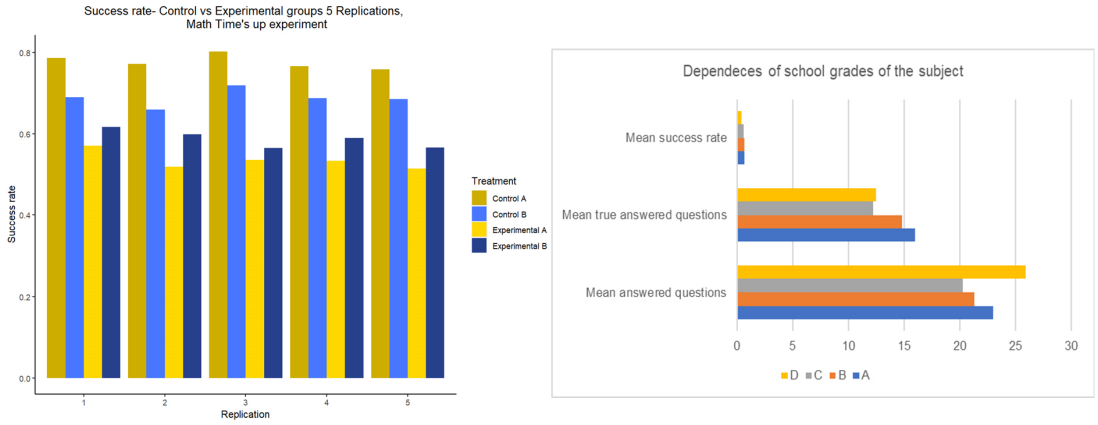
The panel regression analysis showed similar results as of the 4th grade. The results revealed statistically significant coefficients for average subject grades across all levels, with the A mark as the reference value. Students with a C mark had a 0.218-point lower success rate compared to those with an A mark. Those with a B mark had a 16.1% lower success rate, while students with a D mark obtained an average 0.381-point lower success rate than their counterparts with an A mark. Therefore, it can be concluded that average mark of subject and success rate have a positive linear relationship – students having higher grades will obtain higher success rate.

Fig.3. Descriptive statistics results for 6th grade and results with regards of the student's average subject grades.



Source: Ani Atanasova, data collection is via the MTT platform.

Fig.4. Boxplots for success rate for 5 replications for students 6th Grade.



Source: Ani Atanasova, data collection is via the MTT platform.

4. DISCUSSIONS

The results showed a positive response to the gamified approach, with students enthusiastic about replaying and achieving higher scores. Experimental groups quickly caught up with control groups after the second game, indicating faster knowledge acquisition through gaming, driven by competition and leaderboard scoring. A strong positive correlation between subject grades and experiment performance was observed, with higher-graded students excelling in both environments. Interestingly, users were more willing to cheat in the Control environment than in the game-based environment due to the competition factor.

Approximately 50 students from various grades and age groups participated in group discussions, highlighting the value of games for homework practice and in-class engagement according to teachers. All students preferred game-based learning, with 70% favoring multiplayer settings, especially extroverted students. They reported higher performance and decreased boredom compared to traditional tests and acknowledged that in-game communication boosts motivation and likely enhances performance. There were differences in perceptions between school students and adults, with the former showing more positive attitudes towards game-based learning. Additionally, students reported feeling less anxious when using game-based assessments, viewing them as enjoyable rather than evaluative experiences. Despite study challenges, teachers' responses showed a positive view of game-based learning, noting increased engagement and knowledge in the subject. Surveys indicated that over 90% of students believed games enhance learning and participation. These findings highlight gaming's potential in education, emphasizing the importance of catering to diverse student preferences to enhance the educational experience.

5. CONCLUSIONS

In summary, the analysis suggests that game-based learning, especially through the Multiplayer Team Training platform, positively influences student engagement and knowledge acquisition. The identified preferences and recommendations offer practical guidance for educators and curriculum designers aiming to incorporate game-based learning methods. While recognizing the benefits, exploring potential negative effects contributes to a holistic understanding of the challenges and opportunities in gamifying education.

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