

Gamification and a Leaderboard-Based Mathematics Game

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One of the most used game design elements in gamification design is leaderboard, a scoreboard showing participants' current scores and rankings. Though many studies suggest the positive effects of leaderboard on participants' learning and motivation (Kalogiannakis, Papadakis, & Zourmpakis, 2021), research also shows that not all students benefit from the use of leaderboard (Andrade, Mizoguchi, & Isotani, 2016; Nicholson, 2013). Based on self-determination theory (SDT) (Ryan & Deci, 2017), we designed a study where undergraduate math students completed a leaderboard-based review, and addressed two questions: **(RQ1)** How are students' perceived autonomy and competence associated with their enjoyment and intention of continued participation? **(RQ2)** How is student actual competence associated with their enjoyment and intention of continued participation?

Method

In an undergrad math course, *Real World Math Skills*, we created a gamified quiz (Quizalize, n.d.) to review content that focused broadly on *Contending with Change* (e.g., linear & exponential modeling, & rates of change). During class, 47 students answered 24 Quizalize problems, while a leaderboard was projected in real time. Finally, students completed a survey with 19 Likert questions (1: strongly disagree to 7: strongly agree). These survey items also aligned with a specific sub-category (Competence, Autonomy, Enjoyment, & Intention of continued participation) and we considered the mean of students' ratings on survey items in each sub-category. We used student performance data (i.e., total number correct on quiz) to represent student actual competence.

Findings

Considering the correlations among variables, student actual competence was not correlated with either enjoyment or intention of future participation. Instead, student perceived competence was significantly correlated with both. We also found strong correlations ($r \geq +.70$) (Creswell & Guetterman, 2019) between perceived autonomy and both enjoyment and intention of future use. Based on these correlations, we ran linear regressions to understand how well perceived competence and perceived autonomy predict student enjoyment and intention of future participation, respectively. The findings showed that perceived competence and perceived autonomy significantly predict student enjoyment and intention of future participation.

Significance of the Study

Our findings suggest that effects of leaderboard-based math practice on student enjoyment and intention for future participation are varied. These variations were not related to student actual competence. Instead, they were related to students' perceived competence and autonomy as predicted by SDT. Regarding Math Education and gamification implications, findings helped researchers and educators understand why and how students responded to gamified activities differently. Thereby offering a way to explain inconsistent findings in leaderboard research and providing insights about how to tailor leaderboard-based activities to optimize effects of intervention on all students.

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