# GAMIFYING COLLABORATIVE SYSTEMS: TEAM VS TRADITIONAL LEADERBOARDS IN IMPROVING ONLINE DISCUSSIONS

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## ABSTRACT

*Gamified collaboration systems can be effective in improving user motivation to engage with an online community. Leaderboards are among the most popular methods used to improve system engagement in various non-game applications. The aim in the present study is to compare two popular leaderboards, traditional (individual) and team leaderboards, for improving engagement in online discussions. Overall, traditional leaderboards were significantly more effective in increasing two dimensions of engagement: behavioral and cognitive. The research provides insights into the efficacy of leaderboards and alternatives to address low engagement in collaboration systems such as online discussions.*

**Keywords:** online discussions, leaderboards, engagement, teams, community

## INTRODUCTION

Online discussions are critical collaboration systems that enable groups to advance toward their goals. Engagement in online discussions, however, is difficult to maintain (Cheung & Hew, 2005; Hara, Bonk, & Angeli, 2000; Hewitt, 2005). Leaderboards have been shown as one of the most popular methods of improving engagement in online systems (Mese & Durson, 2019; Andrade et al., 2020). By ranking players according to their relative success in achieving a task, leaderboards are said to increase engagement by providing a sense of competition in which the user's performance in completing the task is placed in relation to the performance of others (Butler, 2017; Garcia et al., 2013). However, the research has been mixed showing that leaderboards can result in decreased engagement (Hanus & Fox, 2015; Jia et al., 2017). A significant reason for the negative outcomes is related to improper leaderboard design (Cwil et al., 2020; Jia et al., 2017; Ninaus, 2020). For example, the traditional leaderboard depicting individual users and scores inherently rewards players at the top with a sense of accomplishment as opposed to players at or near the bottom of the leaderboard who may perceive it is impossible to reach the top of the leaderboard (Ostlund et al. 2020). In contrast, team-based leaderboard designs avoid alienating lower performing users by providing a ranking of the entire team's performance.

Accordingly, there remains a significant gap in the literature in which leaderboard designs are compared for their efficacy in promoting engagement with the information system. The aim of this study is to address this gap by exploring design principles influencing engagement for two popular leaderboards for possible differences in their effect on both cognitive and behavioral engagement with an online discussion.

Consistent with Fredricks et al. (2004) established model for engagement, the goal of this study is to separately evaluate traditional and team leaderboards for their potential in evaluating behavioral and cognitive engagement. Toward this goal, each design element was evaluated in an online, undergraduate information systems course in which all students were exposed to a single leaderboard each week, either the traditional leaderboard or team leaderboard. The independent variable was the use of the different game design elements: traditional leaderboard vs. team leaderboard. The dependent variable consisted of

two forms of engagement: behavioral engagement, (measured through posts and replies in online discussions) and cognitive engagement (measured through student grades in the discussion forums).

The current study contributes to the extant literature in at least three ways. First, both traditional leaderboards and team leaderboards are compared as game elements for their respective ability to promote user engagement in online discussions. Second, from a theoretical perspective, the research provides insights into the role of leaderboards in online discussions for inducing active engagement and increased cognitive performance. Finally, from a practical perspective, the research provides insights into alternatives to address low engagement in asynchronous online discussions reflected in both the quality and quantity of discussion posts.

The paper is structured as follows: in the following section we give a brief overview of related work, concluding with a declaration of our hypotheses. Next, we describe the methodology followed by the results obtained and a discussion of key findings and insights. Finally, conclusions are presented and opportunities for future research are highlighted.

## LITERATURE REVIEW AND HYPOTHESES

The literature review will focus on related work in the areas of leaderboard designs and engagement in online discussions.

### Leaderboard Designs

Leaderboards can be defined as a visual display that ranks players according to their accomplishment (Werbach & Hunter, 2015). In general, leaderboards reflect the performance of users in comparison with other users promoting social-comparison as a means to improve the outcome of a particular task. While, overall, leaderboards have been shown to improve engagement with the system, improper design of leaderboard can contribute to negative outcomes in the form of less engagement (Hanus & Fox, 2015). In general, the research on the design of leaderboards has been classified into three main categories: absolute, relative, and team based (Cunningham & Zicherman, 2011).

**Traditional leaderboards**. Traditional, or global leaderboards, represent the most common type of leaderboard displaying individual users and their scores. Leaderboards designed in this manner inherently reward players at the top with a sense of accomplishment as opposed to players at or near the bottom of the leaderboard (Ostlund, 2020). Jia et al. (2018), for example, investigated preferences of leaderboards where the user's name was shown at the top, middle or near the bottom in different domains. Players at the top of social leaderboards reported positive perceptions of the leaderboards and players at or near the bottom reported negative perceptions. In contrast, Sun et al. (2015) reported users in second, fourth, or seventh position on the leaderboard reported higher satisfaction than individuals in other positions on the leaderboard.

Cwil et al. (2020) examined if absolute leaderboards were preferred over other forms of presenting the information, such as in a traditional table. Respondents were asked to compare two different methods of score presentation – a traditional one (table-based) and one in the form of a ranking (leaderboard). Results

demonstrated the majority of users preferred/found it more motivating when results were presented in a leaderboard rather than in a traditional table.

**Relative leaderboards**. In studies using relative leaderboards, users only see their rank as compared with the other users below and above them. Consequently, users will feel less discouraged when ranked lower. However, this type of leaderboard provides no mechanism to provide ranking information for all users. Landers et al. (2017) demonstrated relative leaderboards to increase task performance as opposed to absolute leaderboards. Ninaus (2020) found similar results and prescribed redesigning infinite leaderboards in a way that the position in the leaderboard does not demotivate the weakest players. In this design, all users interact with "sliced" leaderboards that depict they are performing relatively well and reaching the next top level or grouping is not impossible.

**Team-based leaderboards**. In studies using team-based leaderboards, a user is assigned to a team and the leaderboard provides a ranking of the team's performance which sometimes may also include individual users scores on each team. Consistent with the findings of infinite leaderboards, Ninaus et al. (2020) found teams on highly performing teams were more motivated by the leaderboards. Students in poorly performing teams did not contribute to leaderboard motivation. Hollig et al. (2018) examined team-based leaderboards in relationship to personal competitiveness of the user finding highly competitive individuals regard team-based leaderboards with more value than less competitive users.

**Other leaderboard designs**. Other forms of leaderboards include showing top-performing users only (Martin et al., 2020) and using macro/micro leaderboards together (Park and Kim, 2021). Park and Kim (2021) used leaderboards to provide scaffolding to build on concepts in which a micro leaderboard records tasks completed that ultimately move the user to a new position on the macro leaderboard.

## Engagement in Online Discussions

Asynchronous online discussions represent a critical aspect of collaboration systems. Low engagement, in the form of low quantity and quality of posts, has represented a significant challenge to overcome for online communities (Hara, Bonk, & Angeli, 2000; Hewitt, 2005). While engagement has been defined in many ways, Fredericks et. al (2004) widely accepted (da Rocha et al., 2016; Finn & Zimmer, 2012) model of engagement focuses on examining the three elements of how individuals feel, behave, and think. Accordingly, in the present study, engagement in online discussions was evaluated based on behavioral (active participation) and cognitive engagement (Fredricks et al., 2004).

Active participation in online discussions involves behavioral aspects of composing original posts, reading or viewing other posts, and responding to other discussion posts. Game design elements such as leaderboards or digital badges provide external motivation to engage with discussions via constructive competition toward a goal (Lo & Hew, 2018; Ding, 2019). As the user engages with the game, the motivation to engage can shift from extrinsic to intrinsic (Ryan et al., 1991; Lepper, 1988; Deci, Eghrari, Patrick, & Leone, 1994). Self Determination Theory (Deci & Ryan, 2008) and Flow Theory (Csikszentmihalyi, 1998) describe this as a process in which one identifies with an activity's value and integrates it into their sense of self. In applying flow theory to gamification of asynchronous discussions, individuals are more likely to be motivated to engage with the discussion by clear goals (Locke & Latham,

2006), challenging content, and appropriate feedback. When expectations are not set or vague, online communities struggle with both the amount and type of content in posts (Dennen, 2007).

In order for learning to occur, active participation must be accompanied by cognitive thinking in the discussion. Active participation, alone, will not result in the desired outcome of learning. Common strategies for developing cognitive thinking in discussions include instructor scaffolding (Zhu, 2006), clear guidelines (Ng, Cheung & Hew, 2009), and critical thinking questions (Garrison, 2005). Game elements can provide the intrinsic motivation for individuals to critique, construct, and comprehend knowledge in the context of online discussions (Ding, 2019). For example, in a recent study using digital badges, more individuals in the gamified group reported the online discussions forced them to think harder than those in the non-gamified group (Ding, 2019).

Despite the fact the leaderboard remains the workhorse in gamifying systems, there remains a significant gap in the literature in which leaderboard designs are compared for their efficacy in promoting engagement with the information system. Accordingly, the aim of this study is to address this gap by exploring design principles influencing two dimensions of engagement, behavioral and cognitive, with an asynchronous online discussion board.

Following are the two hypotheses that guided the study:

H1: Traditional leaderboards and team leaderboards will demonstrate significant differences in boosting behavioral engagement for competitive users taking part in an asynchronous online discussion.

H2: Traditional leaderboards and team leaderboards will demonstrate significant differences in boosting cognitive engagement for competitive users taking part in an asynchronous online discussion.

## METHODOLOGY

Subjects were 48 undergraduate students taking online information system courses at a large regional university.

### Experimental Setup

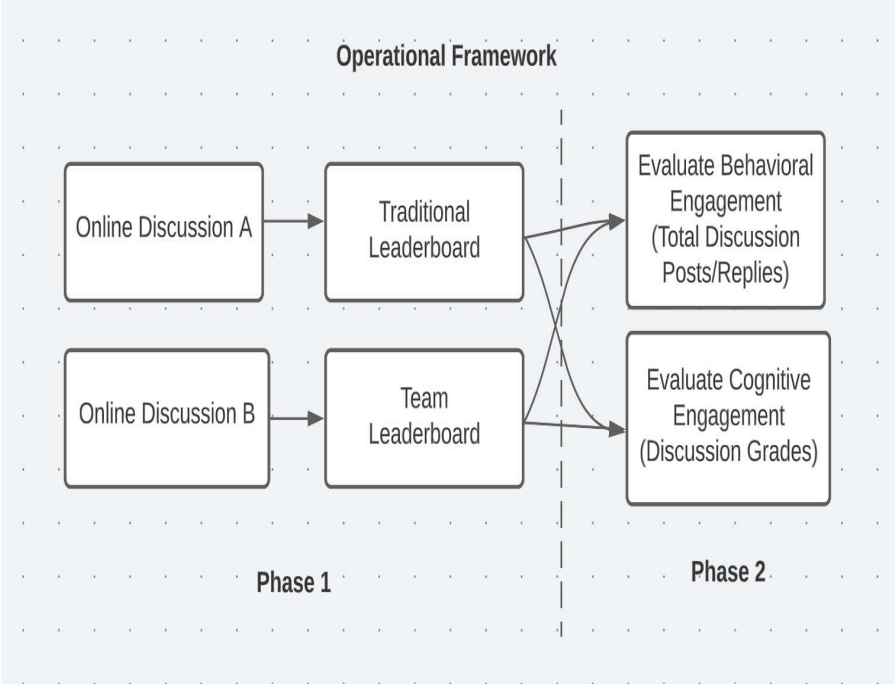
Figure 1 shows the operational framework for this study which used a two phased approach. In phase one, two online courses were developed which were identical in every way with the exception of the method used to gamify the online discussion board. The first course employed a traditional leaderboard and the second course employed a team leaderboard. In phase two of the study, the traditional leaderboard and team leaderboard were each individually assessed for behavioral and cognitive engagement. This design ensured any differences in engagement between the courses could only be attributed to the type of leaderboard.

Subjects were informed at the start of the course and reminded weekly of two goals:

1) For course A, “lead the discussion” by being in the top 20% of total posts and replies, or
2) For course B, help your team “lead the discussion” by surpassing the other teams in total posts and replies.

**FIGURE 1**

**Operational Framework**

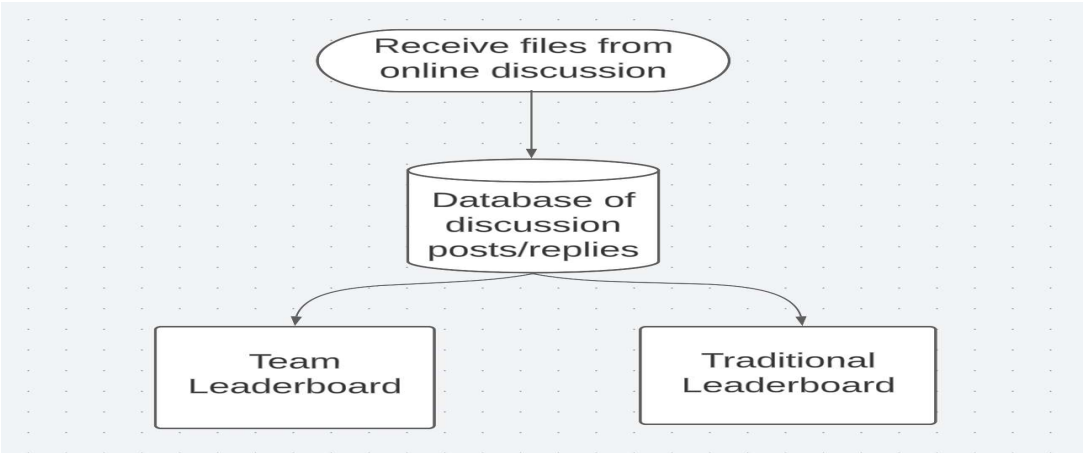



## Leaderboards

A representative artifact (Bovee et al., 2020b) that encompasses the various design elements of concern was used to a) deploy two different leaderboards (traditional leaderboard and team leaderboard) and b) measure the behavioral and cognitive engagement of subjects for each type of leaderboard in improving user engagement in online discussions. Figure 2 depicts the process for creating the traditional leaderboard and team leaderboard from data exported from the discussion group.

**FIGURE 2**

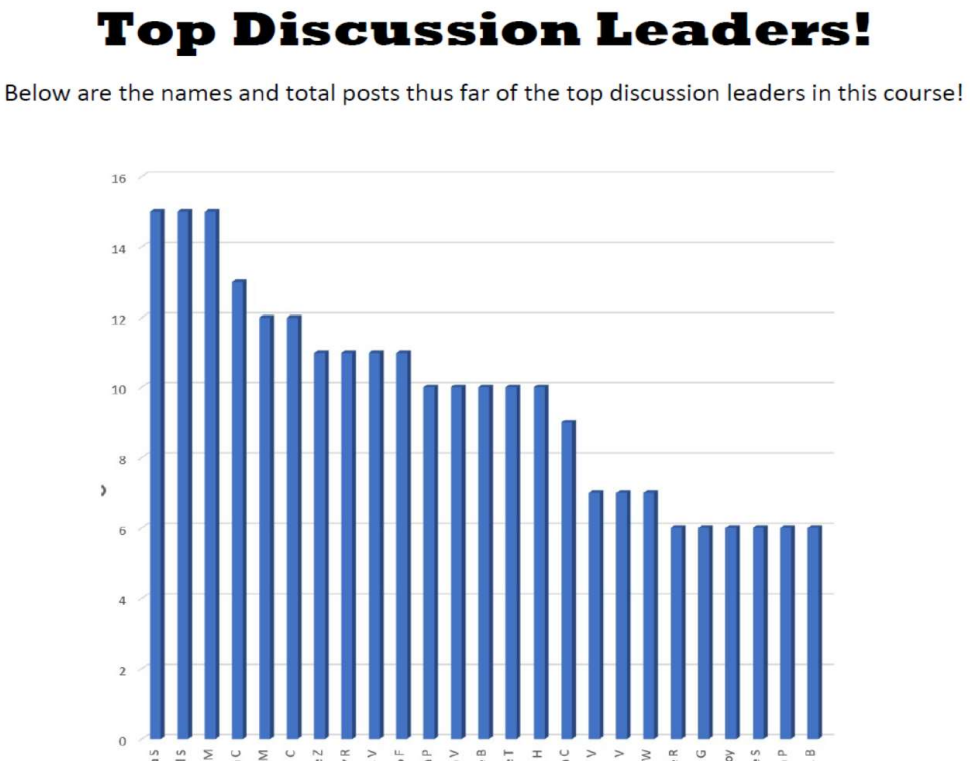
**Leaderboards Used in Online Discussions**



**Traditional leaderboard**. The traditional leaderboard (see Figure 3) was used for students to view their performance based on total posts and replies. In designing this leaderboard, the decision was made to follow the design recommendation from Landers et al. (2017) and Ninaus (2020) to exclude the lowest performing users from view in order to avoid demotivating the weakest players.

**FIGURE 3**

**Traditional Leaderboard**

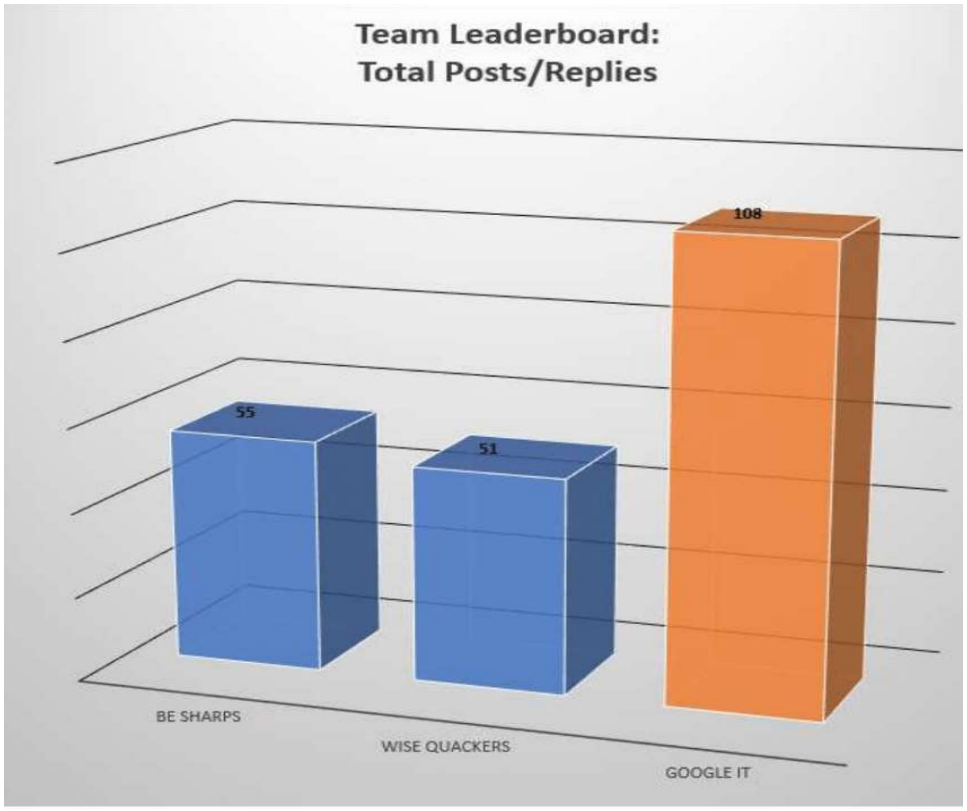



**Team leaderboard.** For the team leaderboard, each student was displayed within a small group (5-10) of other students based on the first letter of last name. For example, students with last names starting with letters A-H were assigned to the team "Be Sharps". See Figure 4 for a screenshot of the team leaderboard depicting the leaderboard for the three teams. This design ensured a random assignment of students that did not relate to performance in terms of number of total posts and replies.

Feedback on performance in the game was provided, primarily, through emails that were sent throughout the experimental timeframe. Subjects were informed at least 3-5 times per week via email of their current position on the leaderboard. Subjects were also able to, at any time, access the online leaderboards to receive feedback on game performance.

**FIGURE 4**

**Team Leaderboard**




## RESULTS

The results are discussed, first, in terms of outcomes in behavioral engagement, and second, in terms of cognitive engagement.

### Behavioral Engagement

Table 1 exhibits the statistical measures of central tendency and dispersion for each variable for each group. The populations of each group are different with 149 points of activity for the traditional leaderboard group (1) and 97 for the team leaderboard group (2). Regarding posts, we observe a mean of approximately 0.99 versus 0.96 with standard deviations of 0.142 and 0.200 respectively. Minimum and median are the same. Maximums vary slightly from 2 for the traditional leaderboard group and 1 for the team leaderboard group. Consequently, we conclude a slight decrease between groups when focusing on student posts. Regarding replies, we observe a mean of 2.09 versus 0.90 with standard deviations of 3.001 and 0.549, respectively. Minimum and median are the same. Maximums vary significantly from 18 for the traditional leaderboard group and 3 for the team leaderboard group. Consequently, we conclude a significant decrease regarding replies for the team leaderboard group. Based on these descriptive measures, we observed an overall decrease in student engagement for the team leaderboard group for student replies and a slight decrease for student posts.

**TABLE 1**

**2-Sample t Test Results**

| Variable | Group | Total Count | Mean | StDev | Minimum | Median | Maximum |
|---|---|---|---|---|---|---|---|
| Student Posts | 1 | 149 | 0.99 | 0.142 | 0 | 0.99 | 2 |
| | 2 | 97 | 0.96 | 0.200 | 0 | 0.96 | 1 |
| Student Replies | 1 | 149 | 2.09 | 3.001 | 0 | 1.24 | 18 |
| | 2 | 97 | 0.90 | 0.549 | 0 | 0.88 | 3 |

The results of the *2-sample t tests* are presented in Table 2. The means for the two variables for each group are shown along with the resulting *p-values* and confidence intervals for the significance level investigated. We observe no significant statistical evidence that the means are different for student posts at a significance level of 0.05. Regarding student replies, the results reveal significant statistical evidence that the means are different at the 0.05 significance level.

**TABLE 2**

**2-Sample t Test Results**

| | Group Mean | | | | 0.05 α | |
|---|---|---|---|---|---|---|
| Variable | 1 | 2 | Difference | P-Value | 95% CI | Equal ? |
| Student Posts | 0.99 | 0.96 | 0.03 | 0.115 | (-0.008, 0.078) | Yes |
| Student Replies | 2.09 | 0.9 | 1.19 | <.001 | (0.590, 1.804) | No |

Following the analysis of each of the two separate dependent variables, specifically, mean differences specific to student posts and student replies, we sought to assess the statistical significance of the difference between groups based on the vector representing the collective means of the two dependent variables. This was performed using Hotelling's $T^2$, which is a specialized form of the MANOVA technique and an extension of the univariate t test (Hair et al. 1995). Hotelling's $T^2$ is appropriate for cases where there are multiple dependent variables and one independent variable consisting of two categories – in our case, traditional leaderboard-based discussion boards vs. team leaderboard-based discussion boards. Results included a test statistic of 17.812, F statistic of 8.844 with 2 degrees of freedom, and a p-value of less than 0.001. Consequently, from a collective vantage point, we reject the null hypothesis that the vector means are the same and affirm there is an overall difference regarding the effect of the two groups on the two dependent variables. We conclude there is a difference in student engagement between traditional leaderboard-based discussion boards and team leaderboard-based discussion boards.

The three statistical activities, descriptive statistics, 2-sample t tests, and Hotelling's $t^2$, facilitated a means of triangulating towards a wholesome set of conclusions when comparing traditional leaderboard-based discussion boards and team leaderboard-based discussion boards. We observe no statistical difference

regarding student posts; however, we observe a significant statistical difference between student replies. Consequently, we conclude no change in engagement regarding posts; however, we observe an increase in engagement regarding replies for the traditional leaderboard at the 0.05 significance level. The latter does support H1, that traditional leaderboards and team leaderboards will demonstrate a significant difference.

### Cognitive Engagement

Discussion grades were retrieved from the university's Learning Management System. The Analysis consisted of statistical discovery of mean differences between the course using a traditional leaderboard (group 1) and the course using a team leaderboard (group 2). Each student's discussion grade was determined using the same grading rubric which was employed in both groups. Average grades were analyzed using a 2-sample t test at the 0.05 significance level.

In the course using a traditional leaderboard, students received an average of 9.69 points with a standard deviation of 6.39. In the course using team leaderboards, students received an average of 5.94 points with a standard deviation of 6.78. Based on this data, we observe the discussion grades were statistically different at the .05 significance level with a p-value less than 0.00001. We accept the second hypothesis (H2), that traditional leaderboards and team leaderboards will demonstrate a significant difference in boosting cognitive engagement for users taking part in an asynchronous online discussion.

## DISCUSSION

The aim in the present study was to compare two types of leaderboards, team leaderboards and traditional leaderboards, for possible differences in their effect on two dimensions of engagement (behavioral and cognitive) with an asynchronous online discussion board. The findings suggest traditional leaderboards, in contrast to team leaderboards, are a particularly effective way to increase both behavioral and cognitive engagement.

### Behavioral Engagement Differences

This study found traditional leaderboards were more effective than team-based leaderboards in improving behavioral engagement, in the form of total posts and replies, with an online discussion. There are two possible reasons for this finding. First, regarding team leaderboards, it appears that users assigned to the teams which did not perform well became discouraged with the ability to control the outcome of the game which, in turn, led to a reduction in total posts and replies. Second, the design of the traditional leaderboard may have played a role as the lowest performing users were excluded from view. This design decision, consistent with findings from Landers et al. (2017) and Ninaus (2020), seems to avoid demotivating the weakest players as was shown with users assigned to low performing teams in this study.

### Cognitive Engagement Differences

In regards to cognitive engagement, the study found a significant difference in student grades for the course which employed a traditional leaderboard. To ensure fairness in grading between the two courses, both courses were created identical in every respect including the same lecture videos and grading rubric. The only difference between the two courses was the type of leaderboard.

There are at least two reasons for the improved grades for students using a traditional leaderboard. First, given the fact users on lower performing teams were less behaviorally active in the form of replies to discussions, it is reasonable to assume there was a corresponding correlation in reduced learning from the discussion board. Second, the decision to remove lower performing users from view in the traditional leaderboard may have resulted in a greater overall percentage of users who did not give up and remained engaged with the learning process to the end of the course. Ultimately, this created a significant difference in the average grades between the courses.

## CONCLUSIONS

Despite the fact that leaderboards remain among the most popular methods in promoting engagement with online systems, little is known about how a leaderboard's design can result in either improved or detrimental outcomes in community engagement. The aim in the present study was to address this gap by examining two popular leaderboards, team and traditional, for possible differences in their effect on behavioral and cognitive engagement. Each leaderboard was evaluated in two online, undergraduate information systems courses that were identical in content and instruction with the exception of the type of leaderboard used in the online discussion. The independent variable represented the use of two leaderboard designs: team vs. traditional. The dependent variable represented two forms of engagement: Behavioral engagement, (measured through posts and replies in online discussions) and cognitive engagement (measured through student grades in the discussion forums).

Our findings suggest traditional leaderboards are a particularly effective way to increase both behavioral and cognitive engagement in collaboration systems such as online discussions. While previous research has shown traditional leaderboards can negatively impact engagement for students appearing at or near the bottom of the leaderboard (Glover, 2013; Hanus & Fox. 2015), traditional leaderboards which remove the lowest performing users from view, seem to offer better results than team leaderboards in both behavioral and cognitive engagement.

The present study makes several important contributions to the information systems literature: First, we fulfill a significant need in online collaboration research for more studies which evaluate methods to improve engagement. Second, we provide a valuable framework to address low engagement in online discussions via the gamification of an online discussion board. Finally, from a practical perspective, our study shows that the implementation of traditional leaderboards versus team leaderboards are particularly effective in promoting increased collaboration and engagement with online discussions.

The present study focused on two of three aspects of engagement: behavioral and cognitive (Fredricks et al., 2004). Future studies should focus on affective engagement through qualitative methods and the use of established research instruments such as the technology acceptance model (Davis, 1989) and/or IMMS (Huang et al., 2006).

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