

EXPOLORING STUDENT ENGAGEMENT VIA GAMIFICATION AND LEADERBOARD DESIGN

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ABSTRACT

Along with the popularity of gamification, there has been increased interest in using leaderboards to promote engagement with online learning systems. The existing literature suggests that leaderboards can result in both improved and detrimental outcomes in engagement. To move the discipline of gamification forward, rigorous studies are needed that compare various leaderboard designs in terms of actual engagement with the information system. Accordingly, this study uses a case study to discover leaderboard designs that lead to engagement in an online discussion. The results provide three conditions needed to improve student engagement via leaderboards.

Keywords: gamification, leaderboards, discussion, engagement

INTRODUCTION

Leaderboards have become commonplace in gaming systems and, more recently, in non-gaming systems to increase user engagement with electronic and other types of systems. Gamification involves the use of game design elements such as leaderboards for non-game applications (Deterding et al., 2011). While “serious” games are designed for a purpose other than pure entertainment, gamification involves the application of game-like elements such as leaderboards, digital badges, and point systems to increase engagement and tap the learner’s normal drive for achievement (Deterding et al., 2011; Huotari & Hamari, 2012). Deriving from the discipline of psychology, gamification is said to induce a state of “flow” in the user via the design of the optimal user experience (Hoffman & Novak, 2009), Chen et al., 2018, Park & Kim, 2021; Swacha & Itterman, 2017). Flow is attained when the mind and body are in complete absorption in the task at hand. Regardless of the methodology used, the goal of all game elements is to have a positive effect on the user’s motivation to engage with the system (Deterding et al., 2011).

However, the specific game design elements used to increase motivation have not been conclusive. There remains a lack of awareness of the effectiveness of each type of game element. The majority of research in gamification has employed multiple gamification elements while using a single measurement of engagement (Broer, 2017; Looyestn et al., 2017). Thus, more studies are needed that offer specifics on the factors leading to engagement for each type of game element used in various settings.

Leaderboards are currently among the most popular elements of gamification (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 actually result in decreased engagement (Hanus & Fox, 2015; Jia et al., 2017). A significant reason for the negative outcomes is related primarily to improper leaderboard design (Cwil et al., 2020; Jia et al., 2017; Ninaus,

2020). For example, the traditional leaderboard depicting all 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).

Despite these design challenges with leaderboards, there remains a significant gap in the literature in which leaderboard designs are compared and contrasted for their efficacy in promoting engagement with the information system. Accordingly, the aim of this study is to address this gap by exploring popular leaderboards used in a gamified, online discussion board to determine differences in engagement. Based on this purpose, the following research question guided the investigation:

What are the factors influencing user engagement for popular leaderboards?

Background and related work

Leaderboards are a “visual display that ranks players according to their accomplishment” (Ortiz-Rojas et al., 2019). 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, negative outcomes can result in less engagement (Hanus & Fox, 2015) based on the design decisions used in creating the leaderboard. In general, the research on the design of leaderboards has been classified into three main categories: global, group or team, and relative based as summarized in table 1 (Zicherman & Cunningham, 2011; Cwil, 2020).

Table 1. Types of Leaderboards

| Global Ranking | Group/Team Ranking | Relative Ranking |
|-----------------------|---------------------------|---------------------------|
| All users | A group of users | Users with similar scores |

Global leaderboards

Global leaderboards represent the traditional leaderboard displaying all 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 et al. 2020). For example, Jia et al. (2018) 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 another study, Sun et al (2015) identified associations between leaderboard positions and player satisfaction rankings in a digital game. These studies demonstrated that user preference for leaderboards was related to the user’s position on the leaderboard.

Cwil et al (2020) examined if global leaderboards were preferred over other forms of presenting the information 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. Results demonstrated that most users preferred/found it more motivating when results are presented in a leaderboard rather than on a traditional table.

Relative leaderboards

Relative leaderboards allow users to see their rank as compared to similarly ranked users scoring 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 increase task performance compared to global leaderboards. Ninaus (2020) found similar results and prescribed redesigning global leaderboards so that the user's 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.

Group/team-based leaderboards

In team-based leaderboards, a user is assigned to a team and the leaderboard provides a ranking of the team's performance. Generally, team leaderboards do not provide any mechanism for determining individual scores on the team as the focus is on team performance. Consistent with the findings of global leaderboards, Ninaus et al (2020) found individuals on high performing teams were more motivated by the leaderboards. Students in poorly performing teams did not contribute to leaderboard motivation. Höllig et al (2018) examined team-based leaderboards in relationship to the user's personal competitiveness finding highly competitive individuals regard team-based leaderboards with more value than less competitive users.

Based on the aforementioned literature review, there remains a lack of awareness on the effectiveness of various design elements of leaderboards due to the fact the majority of research in gamification has employed multiple gamification elements while using a single measurement of engagement (Bovee et al., 2020a; Looyestn et al., 2017; Lopez et al., 2019; Schöbel et al., 2020). Moreover, while the leaderboard represents one of the most popular game elements in the research, there is limited research showing the effectiveness of various design elements of leaderboards. The amount of research is even less when evaluating different design elements of leaderboards from a qualitative perspective.

METHOD

The study employs qualitative research methods to investigate the relationship between various leaderboard designs and user engagement. This study uses a qualitative inductive research method to examine perceptions of leaderboards used in an online discussion. Qualitative procedures are used to provide a means for accessing unquantifiable facts about the perceptions of leaderboard designs used in an online discussion. As a result, the qualitative techniques enable the researcher to share the understanding and perceptions of this popular game element from the end user's perspective. The qualitative method used in this study reveals what students think about leaderboards' quality, meaning, perception and context.

Analysis of the leaderboard designs was conducted using a single case study. The Eisenhardt case study approach (Eisenhardt, 1989) was used along with data collected from semi-structured interviews and reports about the discussion data. The Eisenhardt research method is designed to produce in-depth descriptions of perceptions of leaderboard designs related to online discussion engagement. Using a seven-step approach (see figure 1), the research strategy focuses on understanding the dynamics present in a setting.

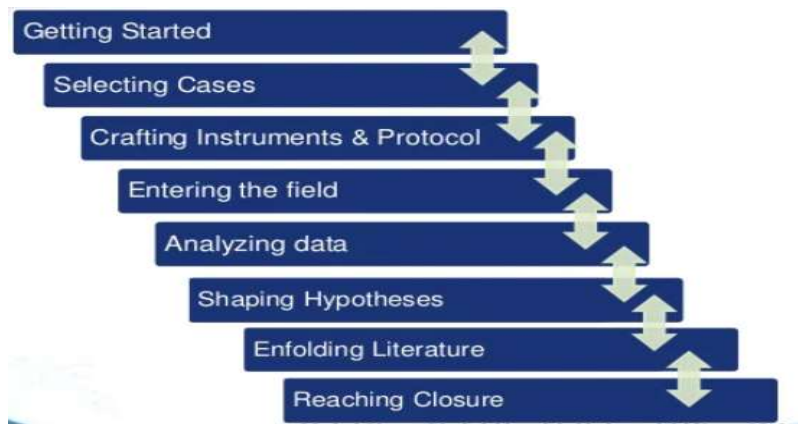


Figure 1: Eisenhardt case study method

This approach is in line with generally accepted approaches to developing relationships or theories from cases (Walsh, 2015; Yin, 2009; Eisenhardt, 1989; Baskerville & Myers, 2004).

The Eisenhardt method was selected for three reasons: 1) using constant comparison with literature it can generate new relationships or theories, 2) emergent theories will be likely testable using measurable constructs, and 3) relationships, models, or theories can be generated because the theory building process is linked to data and other evidence (Eisenhardt, 1989).

Figure 2 below shows the methodology adopted in this study used to determine constructs leading to system engagement when leaderboards are used.

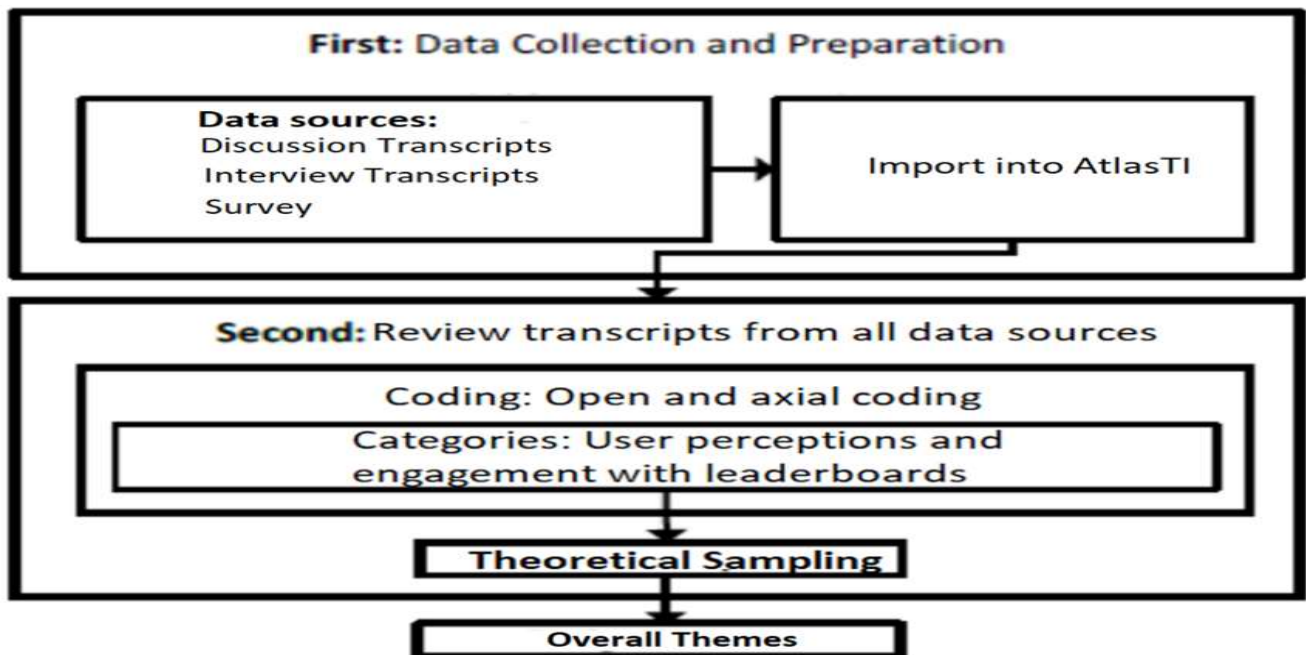


Figure 2: Methodology for creation of overall themes

Leaderboards

The focus for the present study was to use the artifact in Bovee et al. 2020b to create two popular leaderboards (group and relative) which participants then evaluated through semi-structured interviews for leaderboard designs that improve engagement. Figure 3 depicts the process for creating the relative and group leaderboards from data exported from the discussion group.

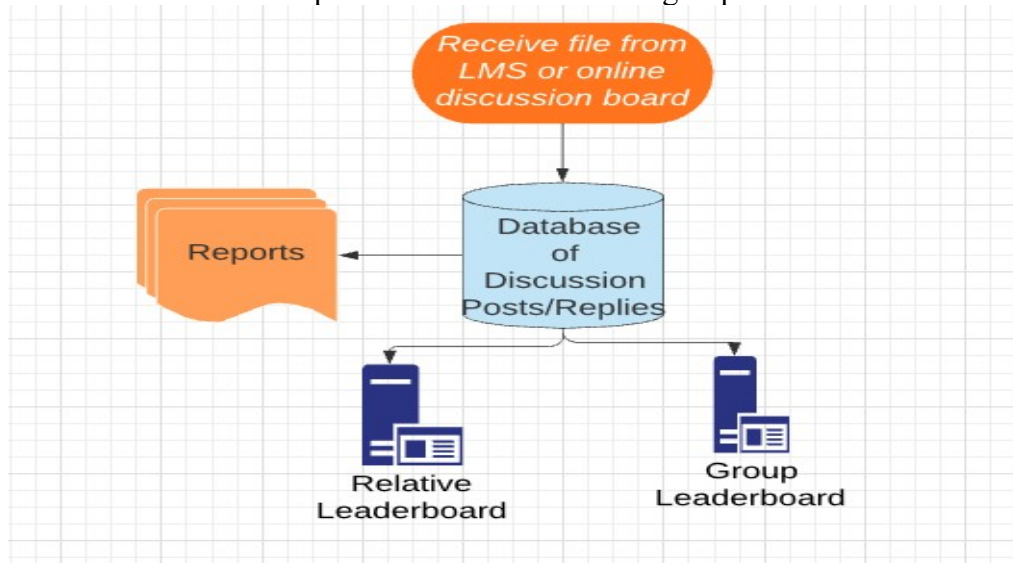


Figure 3: Gamification of discussion board

Relative leaderboard

The relative leaderboard (see figure 4) was used for subjects to view their assigned level based on their individual total posts and replies. In addition to reporting which level each student has attained, the relative leaderboard displayed a message encouraging students to keep posting by indicating how many posts/replies are needed for achieving the next level. There was a maximum of two additional posts/replies for students to reach the next level, ensuring the challenge was realistic and appropriate (Csikszentmihalyi, 1998).

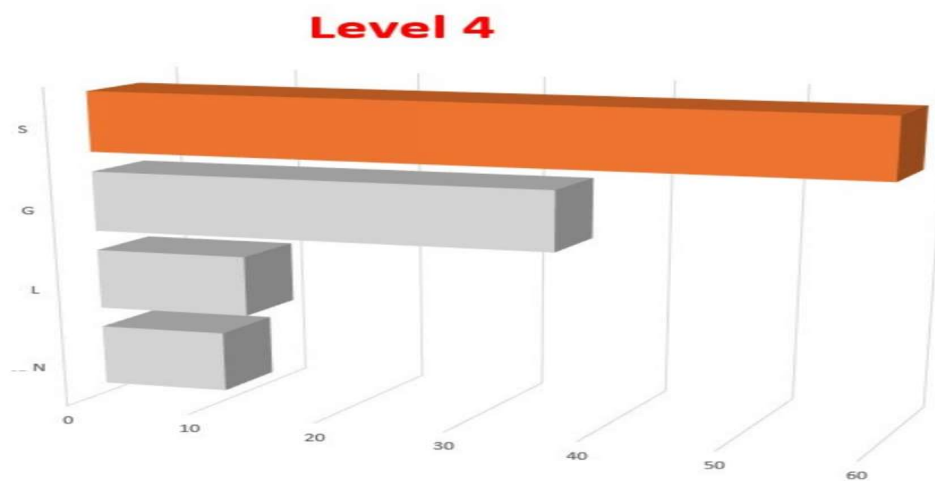


Figure 4. Relative leaderboard

Group leaderboard. For the group leaderboard, each subject was displayed within a small group (5-10) of other subjects based on the first letter of the last name. See figure 5 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 the number of total posts and replies.

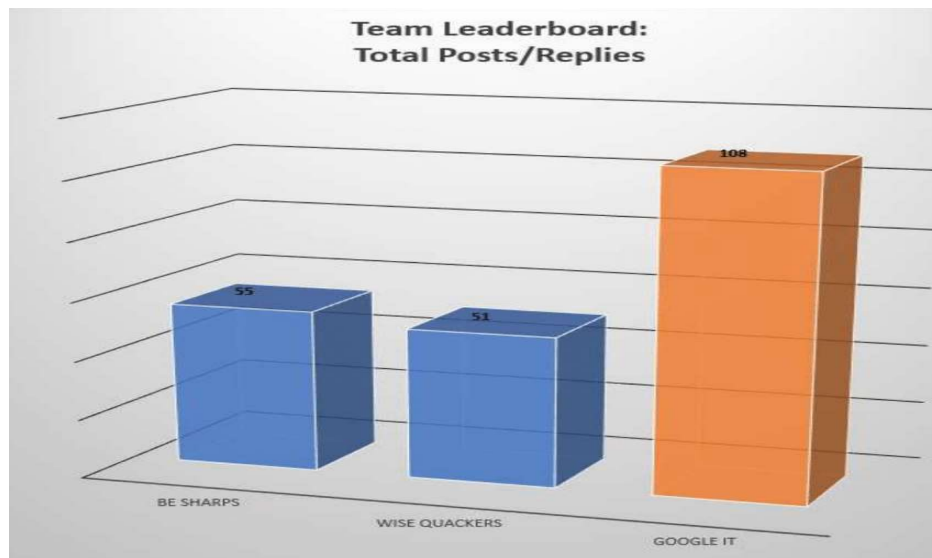


Figure 5. Group leaderboard

The feedback on performance in the game was primarily provided 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.

Following the experimental timeframe, subjects involved in the discussions were scheduled and participated in online interviews with the researcher.

Subjects

Subjects for this study included undergraduate and graduate students enrolled in online courses at a private university. Participants included individuals who decided to participate in the online discussion using leaderboards and those who did not. This was designed to capture the various opinions on the leaderboard designs and why the presence of a leaderboard may have resulted in not engaging with the game.

Subject data were derived from three sources: interviews, online discussion data, and survey data. A total of 36 participants participated in the online discussion generating 15 pages of transcripts. A total of 16 participants participated in the interviews and included undergraduate to graduate students with an age range of 18 to 64.

After providing electronic consent to participate in the study, subjects were given instructions on how to login to Flipgrid; a free, online video-based discussion forum. Once logged into the discussion area, the subjects were given instructions and a short video describing how to participate in the game and submit discussion posts and replies. Both the video and leaderboards described the goal of the game: to lead the discussion in total/posts and replies. For the relative leaderboard, the goal was to move to the next level of posts and replies. For the group leaderboard, the goal was to reach the top of the leaderboard in one's

assigned group. Subjects were informed at the start of the study that periodic updates will be sent via email showing the user's performance in the game based on total posts and replies.

To engage in the discussion, subjects used their webcam or cell phone (via the mobile app) to submit, view, and reply to other video posts by answering questions presented in the discussion. In addition to the directions provided within Flipgrid, participants were automatically sent a welcome email with detailed instructions on participating in the game, goals of the game to lead the discussion in total posts/replies, and links to the two leaderboards to monitor their progress on both the team and level leaderboards.

Data Collection

As suggested by Morse (2002) multiple techniques were used in data collection for triangulation: transcripts from asynchronous video interviews, transcripts from synchronous interviews, and descriptive reports on the discussions. Semi-structured interviews were used to obtain first-hand information on participants' perceptions of the design of each leaderboard game element used in the online discussion as related to improving engagement.

Since the interviews were semi-structured, questions were modified occasionally, and sometimes new questions emerged based on the conversation with the students. Unexpected answers lead to further discussion adding more depth to the data collected through this source. Participants were interviewed once at the end of the experimental period (ten days) to determine whether, and to what extent, the leaderboard they experienced motivated and engaged them. The interview highlighted those aspects of the leaderboard that were most/least engaging and indicated which elements motivated them the most/least. Researchers carefully incorporated member checking (Guba & Lincoln, 1994) throughout the discussions by repeating answers, using a reflective listening strategy, and asking them to verify answers for accuracy. All interviews were transcribed to allow for further analysis and review. Each interview was recorded via Zoom and an iPhone using a voice memo application. Both recording methods resulted in digitally recorded files of the conversations.

Data Analysis

The transcripts derived from interviews were imported into AtlasTi. These transcriptions were reviewed against the recordings and corrections were made to the transcriptions based on the comparisons. Data analysis consisted of the analysis of transcripts created from interviews, transcripts from video discussions, and a survey.

Figure 6 shows an example of how the theoretical constructs emerged from an example participant quote through the open, axial, and selective coding phases resulting in the three main constructs. ATLAS.ti served as the tool for both the transcribed content from the interviews and the coding. ATLAS.ti allowed for systematic organization and the ability to visually represent the relationship of open codes to subsequent steps involving axial and selective codes.

The process of creating the three main themes can be explained in five phases of data analysis. First, the "illustrative participant source" represents a quote from transcript data in interviews, transcript data from discussions, or the survey. For example, in figure 6, "I think the team leaderboards are better because you hold each other accountable". Second, using Corbin & Strauss' (2014) open coding method, various labels of meaning were identified and placed next to each relevant occurrence such as "Didn't want to let team down" as shown in figure 6. Third, axial coding was performed. Data representing events, behaviors,

actions, emotions, perspectives, and interactions that were found to be conceptually similar in nature or related in meaning were grouped under abstract concepts that best represent the design features and perceptions of leaderboards such as “positive engagement teams” as shown in figure 6. Fourth, concepts were elucidated to form the selective codes or categories (Corbin & Strauss, 2014) such as the one in Figure 6: “Team leaderboards can improve positive engagement when rankings are present both between and within teams”. Categories, according to Corbin & Strauss (2014), represent these higher order concepts that can be grouped. Given the purpose of this study, categories served to explain how students perceived the leaderboard and/or game and the effects it has on engagement with the online discussion. Finally, related categories were grouped into theoretical constructs. Theoretical constructs were developed from finding relationships in the categories. as shown in figure 6, figure 7, and figure 8.

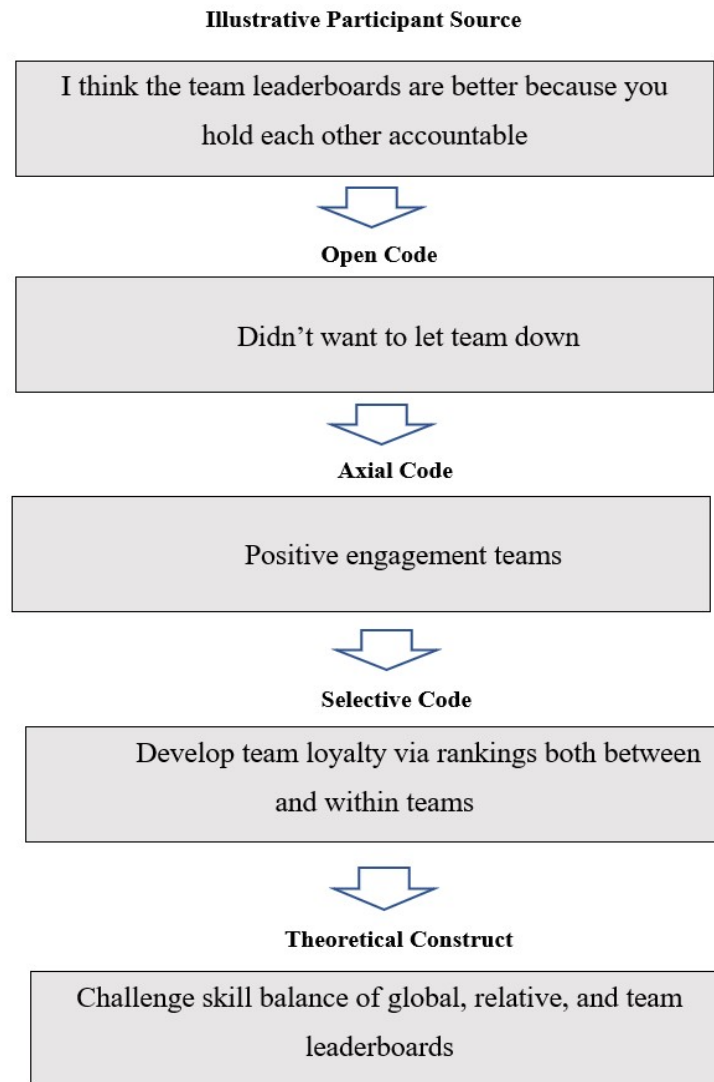


Figure 6 – Emergence of “challenge skill balance of leaderboards” construct

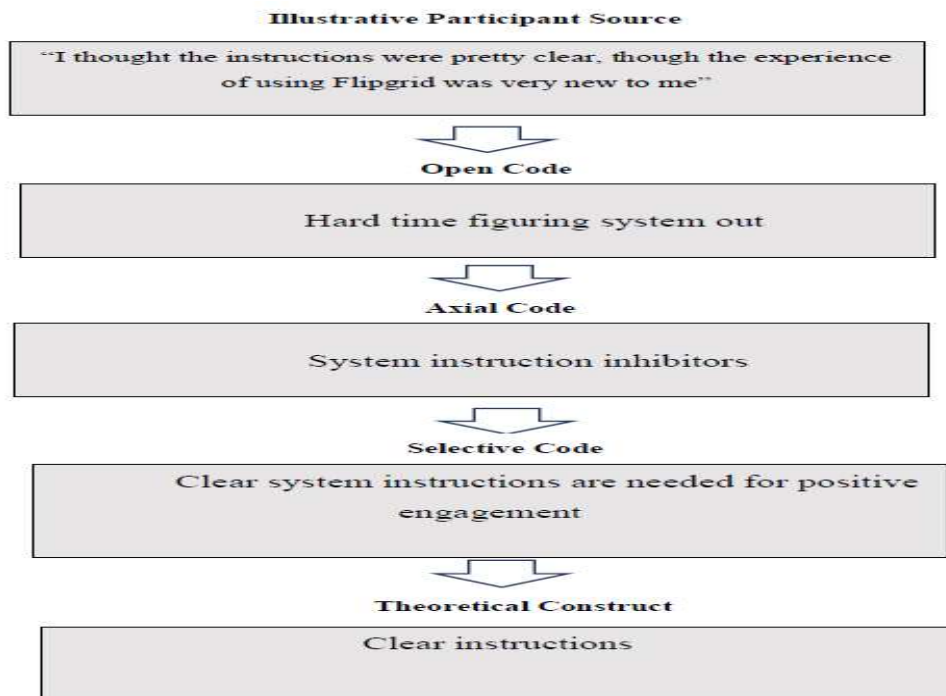


Figure 7 – Emergence of “Clear instructions” construct

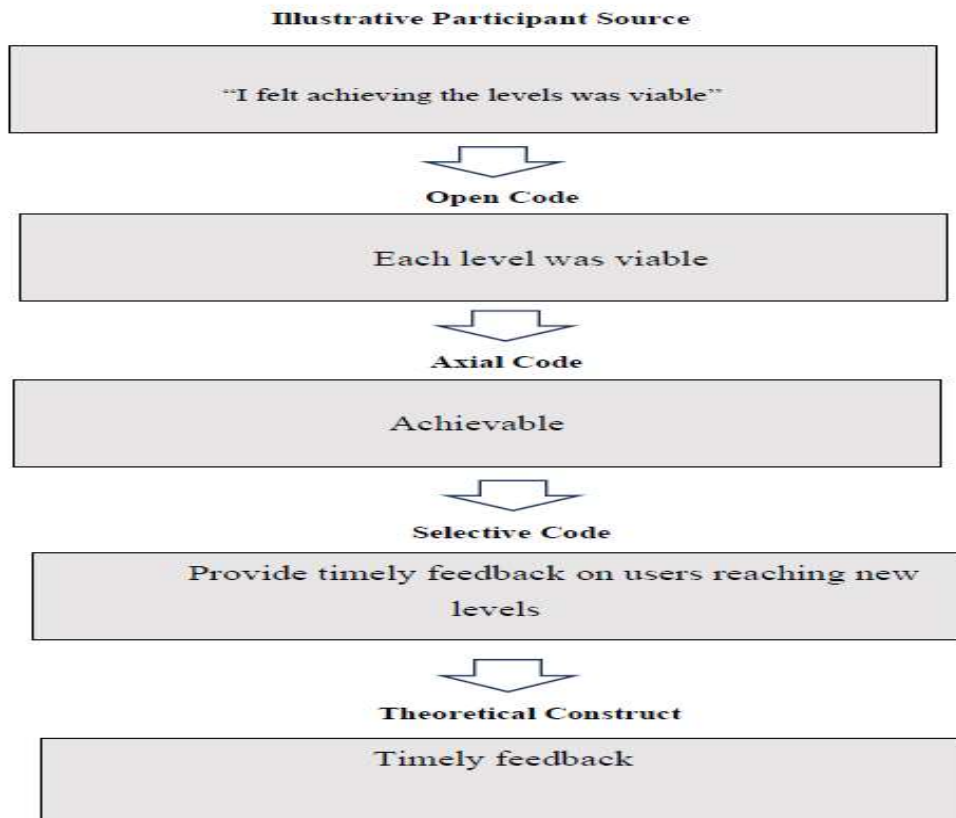


Figure 8 – Emergence of “Timely feedback” construct

RESULTS

The purpose of this project was to answer the following research question:

What are the factors influencing user engagement for popular leaderboards?

Transcripts from the interviews and other data sources resulted in 135 pages and 221 total minutes of audio recording. Only eight participants submitted a survey. These were primarily individuals who were unable to complete the interview but still wanted to provide feedback related to the research question in the study. Three themes emerged as conditions of leaderboard design which promote system engagement. These themes will be the foundation of future research endeavors from which specific design principles and a theoretical model of factors influencing system engagement can be developed.

DISCUSSION

Three significant themes have been identified in relation to design factors influencing engagement in settings where leaderboards are used as the primary game element: appropriate challenge-skill balance, clear instructions, and team accountability.

Challenge skill balance of leaderboards

The most significant finding in this study is in the identification of principles specific to each type of leaderboard. The data in this study demonstrated that global, relative, and team leaderboards each have specific design features that create differing levels of challenge-skill balance. Leaderboards using levels, for example, require levels that are perceived as realistic. In contrast, team leaderboards should be designed with rankings within and between teams. Selecting the correct design features for each leaderboard is, thus, critical to ensuring optimal positive system engagement and avoiding significant negative system engagement outcomes.

The current body of work seems to focus on the efficacy of leaderboards in general. There is, thus, a significant need to better understand the positive and negative outcomes associated with varying types of leaderboards, including level-based, team-based, and global (or infinite). Discussions with participants in this study identified the granular nature of three different types of leaderboards and, therefore, the differing levels of challenge-skill balance based on the type of leaderboard employed.

Clear instructions

While gamification and flow theory literature focuses on the importance of clear goals, this study broadens this construct to “clear instructions”. Clear instructions include both a clear description of the game as well as a clear understanding of the system in which the leaderboard game element is employed. If either of these elements is missing, the goal of system engagement will be limited.

Team accountability

This study demonstrated that team accountability can be developed in two ways: through specific design methods of the leaderboard and the social influences of others. First, team accountability can be developed through the design decisions of the leaderboard. This study used team leaderboards that also included individual rankings within teams. Traditional team leaderboards offer a level of anonymity that can reduce

engagement. Leaderboards rely on social comparison and traditional team leaderboards will yield minimal gains in engagement due to the user's ability to remain unaccountable to the team. The data in this study demonstrated that team leaderboards that employ rankings within teams create power social comparison on two fronts: intra-competition (evaluating scores within the team) and extra (evaluating the scores among teams). Moreover, team accountability is increased as each individual's contribution to the overall team performance is clearly seen.

Second, the social influences of other team members and moderators of the game further contribute to team accountability. Social influences in the acceptance of technology are well established in the literature (Venkatesh et al., 2003). In this study, feedback from the game moderator and other team members acted as powerful social influences to engage with the system.

Limitations and future research

This study has two limitations: the generalizability of our findings in other contexts of gamification using leaderboards, and the role of a video discussion board in this project. First, the general themes in this project were derived from a single case study using an online discussion and, thus, generalizability on leaderboards in other contexts is unknown. Second, a video discussion board was used in this study could have resulted in different outcomes than a traditional text-based discussion board.

Future research should, first, consider the use of quantitative methodologies to evaluate the efficacy of the themes. Within each of the three themes identified in this study, there are opportunities for quantitative research endeavors. For example, under challenge-skill balance, the conclusion that team leaderboards rankings are present both between and within teams could be examined using an experimental approach that focuses on reviewing statistical differences in teams that use individual rankings with teams that do not. Secondly, future research is needed using different forms of discussion boards (i.e., video versus text based) to validate the claims made in this study.

Conclusion

In summary, this research has set out to better understand the perceptions of users toward different types of leaderboards and the potential of these leaderboards for improving system engagement in an online discussion. The Eisenhardt case study method of research was employed to examine these questions using 60 total participants and 321 total minutes of recordings leading to three main categories that influence system engagement: clear instructions; challenge/skill balance of global, team, and relative leaderboards; and timely feedback. Three constructs emerged as factors which promote system engagement when a leaderboard is employed. These themes will be the foundation of future research endeavors from which specific leaderboard design principles and a theoretical model can be developed.

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