CONTENT INDEPENDENT CLASSROOM GAMIFICATION

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Abstract

This paper introduces Topic-INdependent Gamification Learning Environment (TINGLE), a framework designed to increase student motivation and engagement in the classroom through the use of a game played outside the classroom. A 131-person pilot study was implemented in a construction management course. Game statistics and survey responses were recorded to estimate the effect of the game and correlations with student traits. While the data analyzed so far is mostly inconclusive, this study served as an important first step toward content-independent gamification.

Introduction

Gamification, or the use of gaming elements in non-game settings such as the classroom, is becoming a popular method of engaging students in the learning process. Keeping students engaged and focused on class material increases retention of key concepts, increases student connection to the classroom, [1] and enhances students' socioemotional growth, [2] ultimately leading to greater mastery of disciplinary content. [3] While this approach has been successful in other areas, such as industry, this paper focuses on formal education environments. Gamification in educational contexts typically ties the gaming elements directly to course content so students learn while playing the game. While this is one strategy, it is not effective for some students because gamification approaches tied to content introduce challenges for students who are not motivated by the course content or by the game mechanics. Additionally, there is a potential for mismatch between the difficulty level of the game and the students' abilities or needs. [4] Another potential drawback to tying game elements to discipline content is a shift in focus from content mastery to mastery of the game elements, leading to potential misalignment between content expectancy and outcome. Lastly, in making use of a gaming pedagogy, new game content is required for each new lesson. Development of discipline content with gaming elements can be a time-consuming and difficult process for instructors.

The Topic-INdependent Gamification Learning Environment (TINGLE) is designed to engage students in course material using gaming elements, similar to "traditional" gamification, by tying games directly to course content. However, TINGLE uses an alternative approach to traditional gamification in that each student's progress in the classroom is mapped to progress in a game situated *outside* of the classroom and independent of course material. This research received IRB-exemption from our university in August 2015.

Current students in the US have been brought up in a world of games for leisure, and more than 150 million Americans play video games. [5] By creating a game similar to games familiar to students, there is a low barrier to entry. The long-term goal of this project is to award game progress based on effort-based measures in class, such as homework submissions, lab attendance, in-class focus, and in-class contributions to the learning setting. By tying progression in the game to a student's progress in class, the student may find the class more relatable, as their actions in class influence a game with familiar mechanics. The gamified class may also motivate students to complete more difficult homework and exams. Students having positive experiences with giving increased effort on tasks and overcoming challenges can lead to improved persistence and increase the likelihood of engagement in the class.

This paper introduces TINGLE as a research instrument designed to determine specific students' motivations such that gaming elements and reward structures can be customized for each student to achieve maximum benefit. The major points of departure from existing research include:

- A disciplinary- and content-independent game such that instructors do not need to change their existing course materials.
- Identification of the factors that are most positively affected by game engagement to help us understand how games and instruction could

be differentiated for individual students.

- Identification of socioemotional factors such as motivation, interest, and efficacy in the game tied to classroom engagement via the gaming elements.

The remainder of this paper covers the background work, details of the TINGLE pilot study, preliminary results of the pilot study, discussion of the significance of these results, and how future work will improve upon these results to create an environment where student motivation is maximized.

Background Work

This section briefly introduces relevant background work in classroom gamification and game player categorization.

Gamification in Classrooms

There has been growing support within the gamification literature that intrinsic motivation, or motivation that drives one to do something because the activity itself is rewarding, produces greater satisfaction and greater results than does extrinsic motivation, or motivation to do something for an external reward. [6,7] Ziechermann points out that intrinsic motivation is unreliable and variable, and that gamification designers should consider both intrinsic and extrinsic rewards. [8] A further issue with intrinsic rewards in a group setting such as a classroom is that each individual within the group will have different intrinsic motivators, and it will be difficult, if not impossible, to design a setting where each person is intrinsically motivated by gamification within the classroom. Ziechermann asserts that the goal of successful gamification is to create intrinsically motivating extrinsic motivation. One long-term goal of TINGLE is to implement and test such a setting.

A number of classroom gamification user studies have been published. Paul Denny looked at badges for multiple choice responses in class to motivate participation. [9] He found increases in the number of responses, but students did not say they learned more and quality of responses did not improve. However, some students were more engaged with the system than others. Dominguez et al. designed a gamification system for Blackboard, a virtual learning environment and classroom management system. [10] The system featured a leaderboard, trophies, and achievements. Only 44% of the experimental group participated, possibly due some students' expressed dislike for competitive elements in the system. While overall scores and scores on practical assignments were higher in those who participated, scores on written material and participation were lower.

Player Typology

Typology is classification according to general type and a popular method for personality typology is the Myers-Briggs Type Indicator (MBTI). The MBTI places an individual on four bipolar axes, resulting in one of 16 different types being assigned to that individual. [11-14]

Player typology and player traits, the idea that different people like different games and mechanics, have been studied for many years. By understanding why people like certain games, we can better determine which games people will like in advance. In TINGLE, another long-term goal is to use player typology and player traits to identify which games are most likely to be motivating to a particular student. Early research into player typology explored psychological types as a way to explain player preferences. However, recent developments have led researchers in the direction of trait theory, rather than type theory.

Richard Bartle initially attempted to explain player typology by placing a person along two continuous bipolar axes, one being explorer vs. achiever, and the other socializer vs. killer. [15] Many biases led to the need for a better model more grounded in existing psychological literature. Researchers followed up on Bartle's model by attempting to use a player's MBTI results in order to predict player type. This was first explored in the first Demographic Game Design model (DGD1) in 2005. [16] MBTI results were used to classify players as conqueror, manager, wanderer, or participant. In addition, it was found that the common perception of hardcore vs. casual players were not methods of play, but rather were found in all four types, not as a play preference, but as a trait dimension. These findings led to an alternate approach, DGD2, which used Temperament Theory [17] to create player archetypes, such as Logistical, Strategic, and Diplomatic, as well as link to MBTI results, since Temperament Theory and the MBTI have similar theoretical foundations. DGD2 focused on playing preferences, emotional responses to game situations, and a player's game skills. [10] Results from a 1040-player survey indicated that 40% of players prefer to play solo, 17% prefer same-room multiplayer, 19% prefer to play over the internet, and 16% prefer to play massively multiplayer online (MMO) games. In addition, 93% of gamers felt that a story is very important to the enjoyment of a game. 35% feel compelled to acquire everything possible or repeatedly pursue actions because they can make large gains, yet only 9% actively seek out games for this reason.

Subsequent to the development of DGD2, a model called BrainHex was developed using neurobiological factors to create player archetypes. [18,19] Seven defining traits were found, but a player receives a score in each of these seven traits, rather than a single type, as many prior studies had done. Each of the traits represents a motivation a player may have to play a game.

Since BrainHex, there have been more attempts to model player typography, but no major advancements have been made. There have also been a number of studies attempting to utilize gamification in the classroom, [20-22] although this has been a much more recent field of study.

Methods

In order to validate TINGLE, a role-playing game (RPG) was deployed in a 131-student construction graphics class with construction management and civil engineering students during the Fall 2015 semester at Washington State University. An RPG is a game in which players take the role of imaginary characters that engage in adventures, typically in a fantasy setting. While the goal of TINGLE is to eventually tie progress in the game to progress in the classroom, the pilot game did not affect the classroom. This was done to set a baseline for future iterations, in order to account for potential biases due to factors such as the novelty of a game played for class. The game was designed such that the mechanics could be learned in a very short time, allowing players to maximize the time spent playing and enjoying the game, and to minimize risks of frustration and quitting. The mechanics of the game were also designed to only appeal to a subset of player traits, maximizing the measurability of the effects of the game on classroom engagement. This motivational game was developed using Javascript and Limejs in order to run on as many platforms and browsers as possible. Furthermore, Limejs makes it easy to enable mobile support. This was important to prioritize to maximize the number of students playing the game in the short- and long-term.

Figure 1: TINGLE pilot game world map with player character and monster.

The basis of the game is that a player-controlled hero gets five adventures per day to fight monsters. The hero starts out weak, but can use upgrade points acquired from defeating monsters to increase the rate of item drops, the number of monsters that can appear in fights, and the difficulty of those monsters. Item drops from monsters can be used to upgrade the hero's attack, attack rating, defense, and defense rating, making the hero more resilient and better able to survive encounters with more and stronger monsters. This design only rewards actively playing the game and does not reward doing well in class. This was done to set a baseline to improve upon for future iterations of TINGLE with ties back to the class, and to quantify any motivation tied to the novelty of having a game to play for class. One concern with a design where the student needs to interact with the game to succeed in the game is potential addiction. We handle this by limiting the student to five monster encounters per day, which requires only a few minutes per day of active gameplay. This ensures students are not prioritizing the game over their learning, and hopefully, in future iterations, once the student can no longer play the game actively, they redirect the desire for progress to an activity that indirectly helps them progress in the game, which can be any number of course activities, such as doing homework, studying for an exam, or attending class.

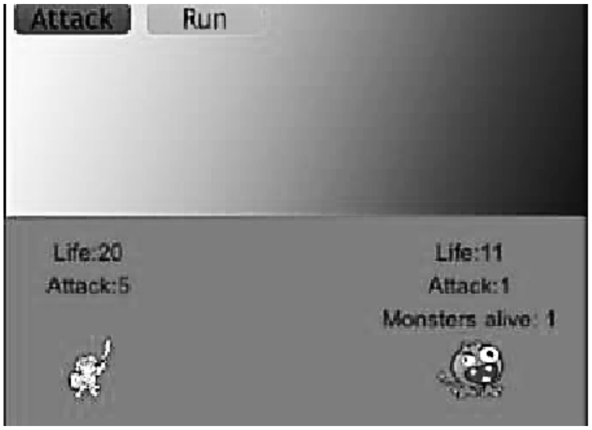

Figure 2: Battle screen.

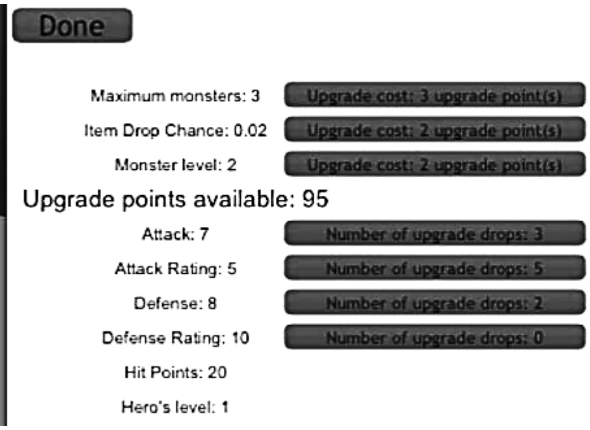

Figure 3: Upgrades screen.

Data collection for the game involved tracking the login timestamps, login durations, and number of clicks recorded because they correlate with the student's engagement. Weekly Likert- scale surveys were also administered via Blackboard, asking the students what benefits they notice from playing the game in terms of engagement, grades, motivation, and fun. In addition, an end-of-semester survey was administered, including more detailed and open-ended questions about prior experience with games as well as their experience with the game in the class.

To record preliminary data regarding the interaction of game type and personality preferences, the MBTI was offered online free of charge to all students in the class during the first few weeks of the semester, before the students began playing the game. 91 students chose to complete the MBTI. The MBTI was selected due to the easy public availability on campus as well as the potential to find significance among any of the four bipolar axes and with each of the 16 MBTI types. This allows for both type- and trait-based analysis. Future work will consider other recent player typology methods. The results of the MBTI were made available to the students. While there were a few weeks between students taking the MBTI and playing the game/filling out surveys, it is assumed that their personality metrics were stationary over that time.

Unfortunately, due to low student participation in the weekly surveys, extra credit needed to be offered for a significant sample of students to fill them out. Surveys were crosschecked with logins in order to ensure the student had played the game that week. As such, we cannot make any causal claims about student motivation leading to increased logins, login durations, or number of clicks within the game. Therefore, the results section will focus on the extent to which MBTI traits predict survey responses.

Results & Discussion

For the weekly surveys, submissions were rejected without the appropriate answer to a weed-out question, as well as if the student had not played the game that week. This left 58 total survey responses, which were used for the following analysis.

Figure 4 shows the distribution of MBTI types among survey responses. There was representation from 11 of the 16 types, with most responders classified as introversion over extroversion, sensing over intuition, and thinking over feeling. There were an identical number of participants classified as judging and as perceiving. Considering the sample was from construction management and civil engineering, this skew makes sense, as the strengths of the field align with the strengths of the traits heavily present in the sample. To determine how much each participant played the game, the number of clicks, or taps on a mobile device, were recorded and aggregated over all play sessions. Figure 5 shows the distribution and frequency of clicks over accounts. Clicks were registered whenever the left mouse button was pressed somewhere in the active game window. While it is possible a click could be registered without changing the game state, it is assumed that all clicks are intentional, and show the desire to interact with the game. Clicks were used over login durations because with no timed logout, participants could be logged in while not being active in the game, or even while not at their computer. A click shows at least a basic level of interaction with the game. Most participants did not experience much of the game — this may have influenced their responses. Without ties back to class, there was minimal external reward, and these results provide evidence that the game by itself was not enough for participants to continue playing.

Survey results were collected using a 7-point Likert scale, where the responses allowed were:

- 1 - strongly disagree
- 2 - disagree
- 3 - slightly disagree
- 4 - neither agree nor disagree
- 5 - slightly agree
- 6 - agree
- 7 - strongly agree

Survey results show that the participants felt the game was least useful for helping them engage with classroom material, with a mean response of 2.98 and standard deviation 1.48. With no ties back to class, this result makes sense. Participants answered more favorably to questions about the extent to which they identified with their game character, with a mean of 3.98 and standard deviation 1.73, and the effect it had on their grade, with a mean of 3.91 and standard deviation 1.67. Since slight extra credit was needed to convince participants to fill out surveys, it is likely that is responsible for that question having a more positive response, rather than the game itself. The remaining questions asked participants the extent the game helped them learn, with a mean of 3.26 and standard deviation 1.57, the extent to which the game was engaging, with a mean of 3.66 and standard deviation 1.66, and the extent to which the game was fun, with a mean of 3.74 and standard deviation 1.72. However, a couple students played a great deal of the game. Both of these participants were ENTJ and their surveys contained neutral or positive responses for most questions. The game had a number of repetitive tasks, and the last two questions were designed to collect data on whether or not there was disparity between what was intended to be an engaging task that only a subset of people might find fun. With responses this close, no such conclusion can be drawn. Finally, to determine the extent to which participants in general liked or disliked the game, the standard deviation of the sum of their responses was taken. At 8.06, this value shows there is spread among participant's overall opinion of the game. Figure 6 shows this distribution. The spread reinforces the idea that no game is right for everyone, and while some participants enjoyed it, some did not.

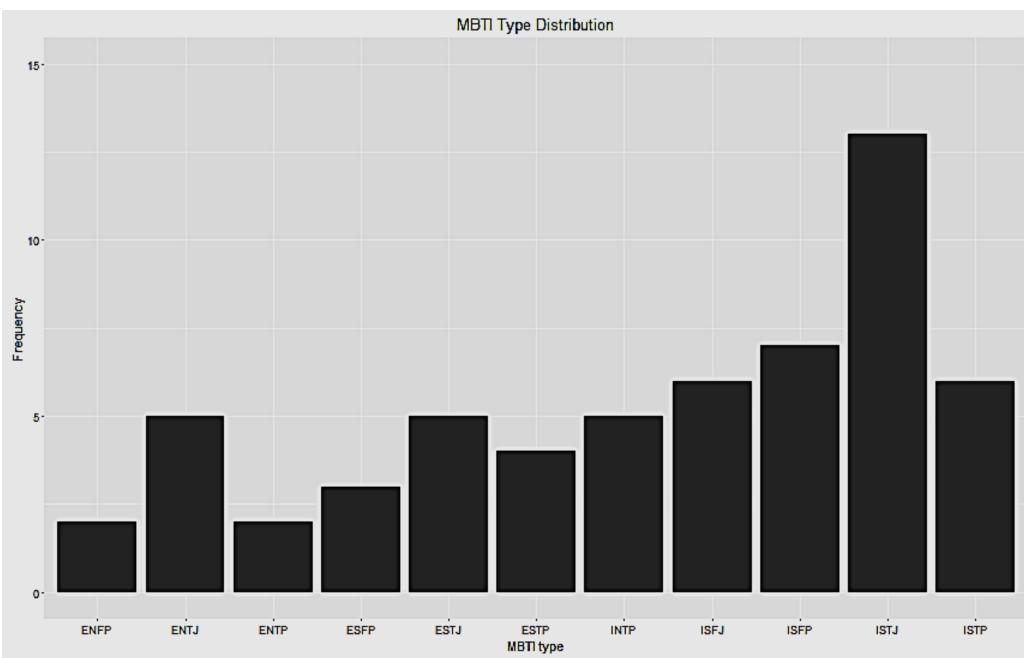

Figure 4: Frequency of each MBTI type in survey responses.

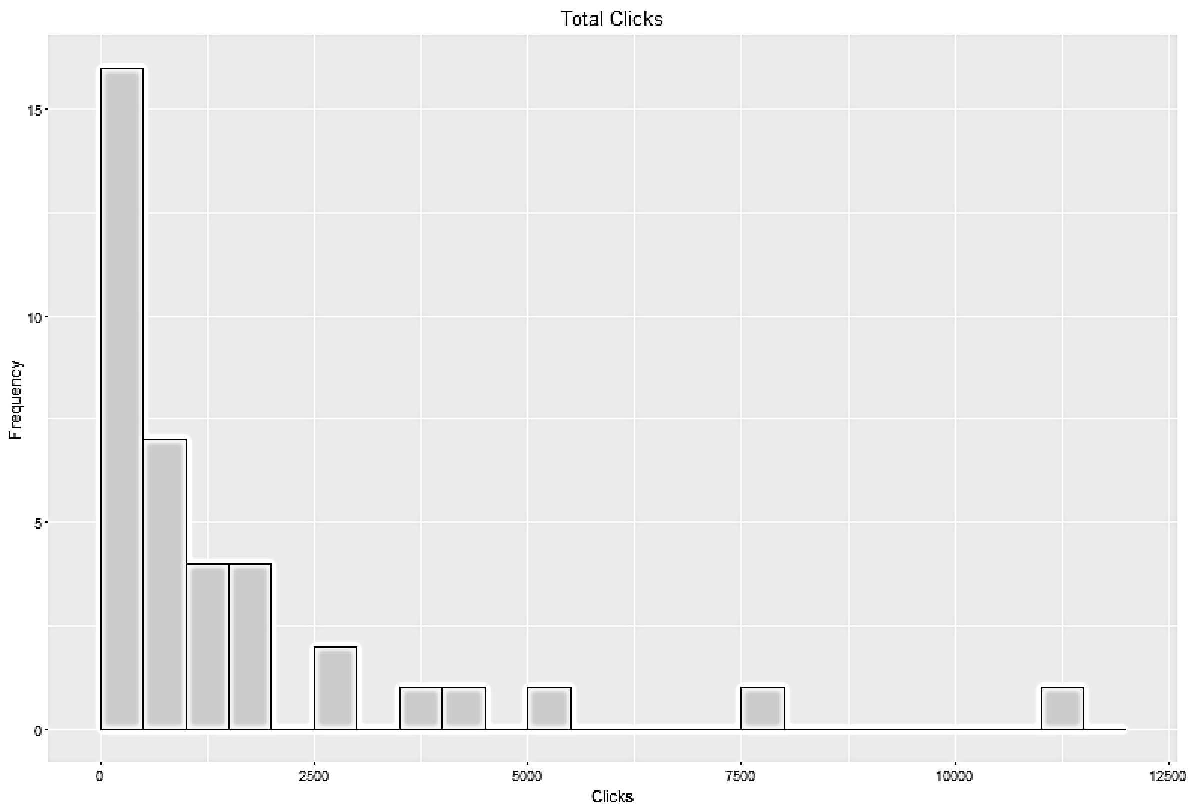

Figure 5: Number of in-game clicks registered by each account over the whole study.

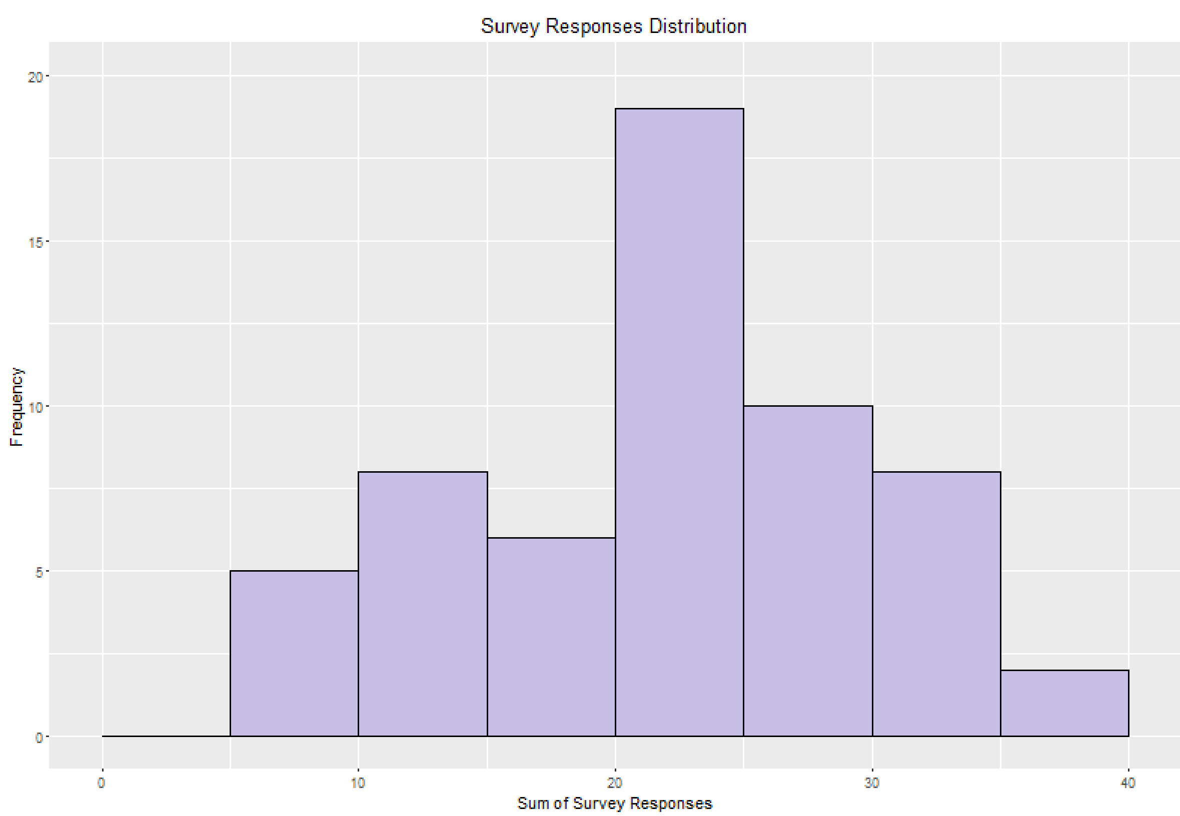

Figure 6: The sum of each student's survey answers.

To determine the extent to which a participant's MBTI results predicted their survey responses, an M5P decision tree correlated each participant's MBTI scores to each individual survey question. [23] M5P was selected for its ability to handle both categorical and numerical data, as well as produce multiple linear regression models at the tree leaves. These results showed no significant correlation, although for the small sample of students who played the game regularly, their responses were more positive than negative. With a sample this small, no significant conclusion can be drawn. Possible explanations for the lack of overall correlation include the game's lack of ties to the class, the number of responses from participants with fairly low playing time, a general lack of enjoyment from the game itself, or that the game was deployed after students had already established a routine for the class. Due to these factors, no causal relationship can be inferred, but evidence from this study suggests that the MBTI may not be a valid predictor of game enjoyment. More recent player typology tests that focus specifically on game mechanics may provide a better baseline for determining whether or not a player will enjoy a particular game.

A qualitative end-of-semester survey was administered to students, many of whom expressed interest in the idea of a class and game tied loosely together. This study provides evidence that a game that is not tied to class does not provide a motivating effect by itself, and provides a baseline for future work. Analysis of these data is still ongoing.

Conclusion/Future Work

This pilot study was designed to determine the extent to which the MBTI could be used to predict how much a student would like a game, and what, if any, effects a game could have on classroom perception without the game having any ties to the classroom. This pilot study has been successful in that:

- A game was designed, implemented, and deployed in a classroom setting.
- 72 of 131 students played the game at least once.
- 38 students completed the MBTI, played the game at least once, and filled out at least one survey.
- Data were collected, providing insight into how to improve the next study.

The game implemented had a number of limitations. With no ties back to the classroom, we cannot yet say if any of the motivation reported by students was due to the game itself. Since the game was implemented in a class that only met once per week, it is possible students were not as engaged with the game as they could have been if they could talk to the instructor or friends about it more often. The implementation of the game was simpler and narrower in scope than most people familiar with games might expect, and some desirable aspects of games participants might be familiar with were not included, such as a story, and progression through different background settings, such as a city or forest. While this game was developed solely to acquire pilot data, a game with more features might have a significantly better effect on students' motivation and engagement. Finally, the game was not deployed immediately at the beginning of the semester, and as such, it is possible students fell into a routine regarding their work, and the game was unable to modify this existing routine, whereas, if it had been available early, it would have been part of a developed routine.

These preliminary results shine light on the potential of gamification-enhanced classrooms. The next iteration of TINGLE will include at least three ties between the game and classroom, and much more data will be collected. Metrics tied more closely to gaming preferences, rather than broad personality preferences, will be collected, to see the extent to which this knowledge improves the survey predictions. A more in-depth game will show the extent of the relationships explored here. Included will be a more exciting battle system, exploration, crafting, quests, and more in-depth character customization, such as skills and classes. Classroom feedback will be implemented into the game such that teachers can have real-time feedback about what students are learning and struggling with, and can optionally plan lessons accordingly. This will be an attempt to create a game with more broad appeal. Since no game is right for everyone, a long-term goal of this project is to use reinforcement learning to select the best game for each student to be playing for a time period based on their personality and gaming background, then continue to follow them throughout their education, updating the most motivating game as the old game gets boring or their preferences change. This maximizes the amount of intrinsic motivation provided by the extrinsic game reward for the class as a whole. The MBTI results from this study were intended to help bias the learner in a direction making this problem easier to learn, and preventing student frustration by minimizing the need for initial exploration. Rather, multiple studies will look at gaming preferences to determine the extent to which they can predict which games a student will want to play more of.

Acknowledgements

We would like to thank Richard Lamb, Jeremy Martinez, Vasiliy Bunakov, Patrick McSweeney, Alex Joens, Chris Fifield, and Sean Brasier for their contributions to this project.

This research has taken place in the Intelligent Robot Learning (IRL) Lab, Washington State University. IRL research is supported in part by grants from NSF IIS-1149917, NSF IIS- 1319412, USDA 2014-67021-22174, and a Google Research Award.

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Biographical Information

Chris Cain is a computer science Ph.D. student at Washington State University doing research in gamification, specifically how to use supervised and reinforcement learning to select individual externally motivating games played outside the classroom which will maximize a student’s motivation to succeed in a classroom setting, without modifying the classroom setting. By tying progress in the classroom to progress in this game, he aims to show an increase in motivation, learning, retention, and grades in as many students as possible without compromising other students’ learning experience.

Matthew E. Taylor is currently an assistant professor at Washington State University in the School of Electrical Engineering and Computer Science. He holds the Allred Distinguished Professorship in Artificial Intelligence and is a recipient of the National Science Foundation CAREER award. Research interests include intelligent agents, multi-agent systems, reinforcement learning, transfer learning, and robotics.

Anne Anderson is an Assistant Professor in the School of Design and Construction at Washington State University. Her research focuses on improving construction coordination efforts through the use of building information modeling (BIM) and emerging collaboration technologies.