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Learning and engagement in a gamified course: Investigating the effects of student characteristics

K. Davis | H. Sridharan | L. Koepke | S. Singh | R. Boiko

The Information School, University of Washington, WA 98195, USA

Correspondence
Katie Davis, The Information School, University of Washington, Mary Gates Hall, Suite 370, Box 352840, Seattle, WA 98195, USA.
Email: kdavis78@uw.edu

Abstract

The current study investigated college students' experiences of a gamified informatics course. We surveyed 139 students aged 18–31 years (M = 20 years, SD = 1.5) enrolled in an undergraduate informatics course focused on social networking technologies. Surveys were conducted at 3 time points during the course (beginning, middle, and end). Overall, we found positive trends with respect to students' perceptions of gamification's impact on their learning, achievement, and engagement in the course material. Although students who played and identified variously with recreational games were more alike than not, we did uncover one notable difference with respect to how students' gaming frequency impacted their engagement in the course. Nongamers expressed somewhat less motivation to do well in the course than frequent gamers. For all other measures of engagement, however, nongamers appeared to be equally engaged by the gamified format of the course as gamers. There were virtually no differences between male and female students' perceptions of gamification. This study contributes new insight into the conditions under which gamification succeeds or fails in educational settings. These insights will be useful to designers and instructors of gamified learning environments as they seek to engage and support a variety of learners.

KEYWORDS

gamification, postsecondary education, teaching/learning strategies

1 | INTRODUCTION

It is no secret that video games are an extremely popular form of entertainment among emerging adults. Fully 67% of young adults aged 18–29 years play video games, and over one out of five (22%) identify as a gamer (Duggan, 2015). In recent years, there has been increasing interest in using game elements in nongame settings such as business, the military, and education to promote participation and skill development (Squire, 2008). Known as *gamification* (Deterding, Dixon, Khaled, & Nacke, 2011), this phenomenon is becoming increasingly popular in higher education, where experience points (XP), quests, leaderboards, and badges are replacing—or in some cases, augmenting—assignments, tests, and grades (Toyama, 2015). The logic behind gamification is to harness the elements of games that underlie their massive success in order to make learning more engaging, customizable, and personally relevant (Gee, 2007, 2008).

But does gamification work? For whom does it work (and not), and why? Researchers have begun to explore these questions as gamification spreads throughout higher education courses. On the whole, existing research points to positive effects of gamified courses, particularly with respect to student engagement and achievement (see Dicheva, Dichev, Agre, & Angelova, 2015). However, as this research is still emerging—along with the phenomenon of gamification itself—the research base is still thin. Especially needed are studies that probe how different types of students respond to gamified learning experiences.

In the current study, we investigated college students' experiences of a gamified informatics course. We surveyed students at three time

points during the course, noting changes in their attitudes towards gamification and the course, with a particular focus on students' perceptions of the impact of gamification on their engagement, learning, and achievement. We examined differences across students to identify whether gamification worked better for some students than others. We were especially interested in whether students who played games recreationally would respond more positively to a gamified college course. This interest was motivated by the recognition that prior experiences and personal interests play a central role in learning-related engagement and interest development (Hidi & Reninger, 2006; Plass, Homer, & Kinzer, 2015). We also examined possible gender differences due to existing gender stereotypes associated with gamer identities (Fisher & Jenson, 2016).

This study contributes empirical evidence relating to the effects of gamification on student engagement and learning experiences at the college level. By investigating differences in prior gaming experience and interest, we contribute needed insight into the conditions under which gamification succeeds or fails in educational settings. These insights will be useful to designers and instructors of gamified learning environments as they seek to engage and support a variety of learners.

1.1 | Theoretical context of game-based learning

There is growing recognition that well-designed games provide rich environments for learning (Gee, 2007, 2008; Plass et al., 2015; Squire, 2008). Squire (2008) calls games "possibility spaces" in which players feel emotionally invested in solving authentic problems that they experience as personally meaningful. The goals are clear, players are given a variety of ways to achieve them, "just in time" supports, and ample opportunities to practice—and fail (Gee, 2008; Lee & Hammer, 2011; Plass et al., 2015). As players progress from novice to expert, they typically do so by being both challenged and supported by fellow players. These qualities of games align with established theories of learning that recognize the important roles of motivation, scaffolding, individualized learning, and social interaction (Plass et al., 2015). As Gee (2008) observes, "[G]ame design is not accidentally related to learning, but rather … learning is integral to it" (p. 24).

There are many types of games, each presenting different opportunities for learning (Squire, 2008). It is therefore not realistic to articulate a single theory of games and learning (Gee, 2008; Plass et al., 2015). *Minecraft* and *Candy Crush*, for instance, have different game mechanics, incentives, narratives, and even ways of using sound. Some games align with behaviourist views of learning, whereas others align with cognitivist or sociocultural views of learning. Plass et al.'s (2015) integrated design framework of game-based learning includes four theoretical perspectives for understanding how specific aspects of a game's design can support learning. *Cognitive* views of game-based learning are concerned with the mental models that players construct through their gameplay and how they connect those mental models to prior knowledge and nongameplay experiences. *Motivational* views examine how games succeed in motivating players to continue playing by providing them with an experience that is both enjoyable and promotes a sense of self-efficacy. *Affective* views focus on the way that games engage players emotionally and connect to their beliefs and attitudes. Finally, *sociocultural* views consider the social foundations of gameplay and how knowledge is constructed and shared among players.

Motivational views of game-based learning represent a sizable portion of existing scholarship on games and learning (Dicheva et al., 2015; Gee, 2008). This work recognizes the notable contrast between young people's deep engagement in playing games and the relative lack of engagement that many youth experience in school. In well-designed games, the goals that players pursue are challenging enough to keep them engaged, but not too challenging to overwhelm or frustrate them. Granic, Lobel, Engels, and Anderson (2014) call this a "motivational sweet spot" and draw parallels to Vygotsky and Cole (1978) "zone of proximal development" (ZPD). Inside the ZPD, learners are given appropriate challenges that push them to achieve just beyond what they are currently capable of achieving. Games can manipulate these challenges so that they are never too easy or too difficult for a particular player. Players are given immediate and concrete feedback on all of their attempts, and they are encouraged to take risks due to the low cost of failure (Gee, 2008; Granic et al., 2014). These qualities—which are often lacking in many classrooms—contribute to players' sense of agency as they watch themselves progress from novice to expert.

Plass et al. (2015) observe that successful games are very good at supporting players' *situational interest*. Hidi and Renninger (2006) distinguish between situational and individual interest. Situational interest refers to the attention and affective engagement that individuals experience in the moment when they are engaging in a particular activity. In contrast, individual interest refers to a more enduring predisposition to engage in an activity repeatedly over time. In their four-phase model of interest development, Hidi and Renninger show how a triggered situational interest can eventually lead to a more enduring individual interest. A situational interest is typically triggered externally by the introduction of surprising information, personal relevance, or an intense experience, which leads a learner to experience focused attention and positive feelings. A maintained situational interest emerges as the learner continues to experience the activity as meaningful and personally involving. Repeated engaging experiences form the basis of an emerging individual interest as the learner comes to value the activity based on previous experience. This emerging interest eventually turns into a well-developed individual interest when the learner has formed an enduring predisposition towards the activity based on stored knowledge and value. Social interaction, including opportunities for collaboration and challenge, is important to all phases of interest development.

Hidi and Renninger's (2006) model of interest development suggests how game-based learning can both trigger learners' situational interest and support the development of a more sustained individual interest in an activity. Core game design principles such as clear goals, immediate feedback, and the low cost of failure help learners gain a sense of mastery through their gameplay (Gee, 2007). This sense of mastery contributes to the development of an enduring disposition to play a particular game, as players come to see themselves as capable, contributing participants (Squire, 2008).

It is worth noting the role of personal relevance in this discussion of interest development and engagement in relation to game-based learning. Students' willingness to engage in an activity at the outset

is shaped in part by their previous experiences and personal interests (Hidi & Reninger, 2006; Plass et al., 2015). It is therefore possible that students who already play games and see themselves as gamers would be more likely to respond favourably to game-based learning experiences. To our knowledge, no research has directly and systematically explored this hypothesis.

1.2 | Empirical research on the effects of gamified learning environments

Because the current study explores students' experiences of a gamified college course, we focus our review of existing research on studies addressing gamification specifically and exclude other forms of game-based learning, such as augmented reality or multiplayer strategy games. We define gamification as the use of game elements, such as points, leaderboards, and badges, in nongame environments (Deterding et al., 2011). Existing research investigating gamification in education primarily focuses on students' engagement and achievement, the effects of specific game elements, and differences across different demographics and learner types. Collectively, this research paints a positive picture of gamified learning environments (Dicheva et al., 2015).

Several studies have found positive effects of gamification on student performance and achievement. Barata, Gama, Jorge, and Goncalves (2013) compared the performance of students enrolled in a gamified college course to students enrolled in a nongamified version of the same course. They found that the gamified course, which included XP, levels, badges, challenges, and leaderboards, reduced grade discrepancies among students and helped them to score better. Similarly, Ibanez, Di-Serio, and Delgado-Kloos (2014) found that gamified learning activities were associated with a moderate improvement in learning outcomes in a college course focused on teaching the C-programming language. Other studies of gamification in undergraduate courses have found similar positive effects on student performance and achievement (e.g., Betts, 2013; Maia & Graeml, 2015; Xiang, Ann, Hui, & Yew, 2014).

In contrast to this positive trend, Hanus and Fox (2015) found negative effects of gamification on students' final exam scores in an undergraduate communications course. In addition, Dominguez and colleagues found mixed results in their investigations of a gamified e-learning platform; students performed well on practical assignments compared with students in the nongamified version of the course, but worse on written assignments and assessments of knowledge (De-Marcos, Dominguez, Saenz-De-Navarrete, & Pages, 2014; Dominguez et al., 2013).

The trends relating to student achievement are largely mirrored by trends associated with student engagement and motivation. Banfield and Wilkerson (2014) interviewed undergraduate students enrolled in gamified system administration and security courses. Their analysis found a positive effect of the gamified format on student intrinsic motivation and self-efficacy. Barata et al. (2013) found similar positive effects on student engagement; the gamified version of the college course they investigated resulted in increased online participation and proactivity compared with the nongamified version.

Although the majority of studies identified in our review uncovered positive motivational effects of gamification (e.g., Chen, Burton, Vorvoreanu, & David, 2015; Ibanez et al., 2014; Maia & Graeml, 2015; Xiang et al., 2014), some pointed to mixed or even negative effects on student engagement. Consistent with their negative findings related to student achievement, Hanus and Fox (2015) found that students in the gamified course showed less motivation, satisfaction, and empowerment than students in the nongamified course. Similarly, Dominguez et al. (2013) found that students in the gamified course participated less on class activities, although their initial motivation was higher. These findings support a common concern among critics of gamification that placing emphasis on external reward structures could diminish students' intrinsic motivation to learn (Toyama, 2015).

In an effort to tease apart what aspects of gamification are most effective, researchers have begun to explore students' experiences of specific game elements. In their exploratory study prior to developing a game-like learning system, Cheong, Filippou, and Cheong (2014) identified students' three most preferred game elements to be teams, progress bars, and points. Consistent with this finding, Ibanez et al. (2014) examined students' preferences for different gamified elements and found that the desire to collect badges was the strongest driver of participation in a gamified learning activity. Similarly, the students in Barata et al.'s (2013) study believed that the challenges that required extra work, and which earned them XP and achievements, contributed positively to their learning. Focusing on the role of competition, Sepehr and Head (2013) discovered that although students generally found competition to be highly motivating, the experience of losing a competition had negative effects on their satisfaction and enjoyment. Similarly, Ejsing-Dunn and Karoff (2014) found that competition was motivating for some students but could also harm sociability within the gamified environment.

Researchers have also begun to explore the effects of individual learner characteristics on students' experiences of gamification. Gender represents a common characteristic that has been a focus of several investigations. Despite common stereotypes depicting males as prototypical gamers (Fisher & Jenson, 2016), these studies have not detected any gender differences with respect to student engagement or learning outcomes (Fan, Xiao, & Su, 2015; Papastergiou, 2009; Plass et al., 2015). In one study, 88 high school students were randomly assigned to learn computer memory concepts either through a gaming application or through a nongaming application. Boys and girls found the gaming condition to be equally motivating. There were also no detectable differences in achievement outcomes between boys and girls. Other learner characteristics that have been explored in previous studies include age (Attali & Arieli-Attali, 2015), prior knowledge of course content (Papastergiou, 2009), and learning styles (Fan et al., 2015).

1.3 | The current study

Although existing research exploring the effects of gamified learning experiences are promising, it is well recognized that no single pedagogical approach will work equally well for all students (Davis & Gardner, 2012; Gardner, 2006). It is therefore important for subsequent research to investigate for whom gamification works—and does not work—and why. In the current study, we focused on the effects of students' recreational gaming practices on their experiences of a gamified college course. We chose this focus in light of the important

role that prior experiences and personal interests play in learning-related engagement and interest development (Hidi & Reninger, 2006; Plass et al., 2015). As previously noted, to our knowledge, no research has directly and systematically explored the hypothesis that students who play games recreationally and see themselves as gamers are more likely to respond favourably to game-based learning experiences. We also looked at possible gender differences due to salient gender stereotypes related to gaming (Fisher & Jenson, 2016).

The current study contributes new insight into the effects of gamification in education by exploring the following research questions:

RQ1. What are students' attitudes towards and experiences of a gamified undergraduate course?

RQ1a. Do differences exist across gaming frequency, gamer identification, and gender?

RQ2. To what extent does gamification contribute to students' perceived learning and achievement?

RQ2a. Do differences exist across gaming frequency, gamer identification, and gender?

RQ3. To what extent does gamification influence students' engagement in the course material and ideas?

RQ3a. Do differences exist across gaming frequency, gamer identification, and gender?

2 | METHOD

2.1 | Research context

The research context for the current study was an introductory undergraduate informatics course taught in Winter 2015 at a large public university in the Northwest United States. Focused on social networking technologies, the course explored popular social networks, gaming applications, and messaging applications, including their social implications and information structure. The course was specifically designed for freshmen and sophomores with no background on this subject. It aimed to introduce students to the technological, social, and informational sides of information systems.

At the time of this study, the course was in its fifth iteration as a gamified course. The instructor's motivation for selecting gamification as a pedagogical strategy was based on two primary factors. First, he anticipated that gamification would by a familiar and compelling format for the audience for the course—largely first- and second-year students with an interest in technology. Second, he wanted to test, in a realistic setting, whether the current hype around gamification in education was warranted.

The course was divided into a Big Class led by the instructor and a Small Class led by one of six undergraduate teaching assistants. Students attended the Big Class once a week, where they engaged in an enthusiasm-generating activity that combined play, high interactivity, and learning. They attended a Small Class twice a week, where they took quizzes, peer-evaluated each other's work, and performed activities designed to bolster the course material. The class activities were organized into five types of *accomplishments*: Learners, Speakers, Thinkers, Builders, and Writers. Table 1 summarizes the purpose, structure, and evaluation approach for the five types of activities.

The course used the following game elements: XP, leaderboards, level ups, and badges. All student work, from tests to activities to class participation, carried a certain number of *XP*. Student grades were calculated based on how much XP they accumulated throughout the course. The top 10 XP scoring students in each accomplishment were listed on the *leaderboard*. Twice a quarter, leaders were publically

TABLE 1 Description of the five types of class activities: Learners, Thinkers, Speakers, Builders, and Writers

Course area	Purpose	Statistics	Evaluation
Learners	Primary learning of the course materials through videos and transcripts	25 modules ~350 5-min or less videos and ~2,500 fill-ins	Fill-ins for each video lecture Level up when you finish all lectures in one module
Thinkers	Conceptual questions based on the content of the learner module	One Thinker per learner module 10 Thinkers expected for the course About 150 multiple choice questions in the course	1. (Exposure to the concepts) Take a quiz on the questions 2. (Solidification of the concept) Do a face-off on the same questions where you go head-to-head with another student to see who can answer the questions faster 3. (Application of the concepts) Level up when you write a one-page email on one of the concepts
Speakers	Vocabulary building and verbal performance on the content of the learner module	One speaker per learner module 10 speakers expected for the course. About 250 vocabulary words in the course	1. (Exposure to the vocabulary) Take a quiz on the questions 2. (Practice the vocabulary) Do a face-off on the same questions where you go head-to-head with another student to see who can answer the questions faster 3. (Apply the vocabulary) Level up when you write a one-page essay that uses all the vocabulary of the module
Builders	Technical skills	Nine exercises, nine, workshops, nine small projects that build towards an end-to-end system design project	Participation credit for workshops, variable points for exercises, and variable points for miniprojects
Writers	Written expression and opinion formation	One prompt per learner module 3 essays expected for the course 30-point rubric for all evaluations	1. Diagram an argument 2. Peer eval of your argument 3. TA eval of the argument 4. Turn argument into a logical essay 5. TA eval of essay 6. Wordsmith essay to final 7. TA eval of final essay

Note. TA = teaching assistant.

recognized and given a small prize. Students *leveled up* within a particular accomplishment by moving through levels of attainments. For instance, the Writer accomplishment included 25 essay prompts, and a student needed to complete three drafts of an essay in order to move up to the next level of attainment. For each accomplishment, there were a certain number of levels that a student was expected to attain to reach an A in the course. *Badges* were used as social capital and minor rewards. For example, each week, the XP leader in each accomplishment category was issued a "Best of Class" badge. Other students would see the badge when they saw the student in the system. In some cases, a small amount of XP accompanied the badge.

The gamification paradigm suggests a self-paced experience. However, in previous iterations of the course, the instructor found that some students had difficulty pacing themselves throughout the quarter in the absence of deadlines. To support these students, the instructor incorporated into the learning platform an expected amount of work for the week and showed students exactly where they were relative to the expected amount of work. He also imposed "gating" on certain assignments in order to encourage students to pace themselves. For example, to accomplish three essays in 10 weeks with three evaluated drafts each, a student must begin early in the quarter and submit drafts consistently week after week.

2.2 | Participants

Participants were undergraduate students enrolled in the informatics course during Winter 2015. Students ranged in age from 18 to 31 years (M = 20 years, SD = 1.5) and were roughly evenly divided with respect to gender (36% female).

We used two approaches to classify students' recreational gameplay. In the first approach, we grouped students according to the number of hours per week they spent playing games. We drew on previous work and recent statistics on young adults' gameplaying patterns (Duggan, 2015; Entertainment Software Association, 2015; Kirman & Lawson, 2009) to identify the following categories: *nonplayers* (0 hr per week), *light players* (1–9 hr per week), and *heavy players* (10 or more hours per week). Fifteen students (12%) were classified as nonplayers, 80 students (62%) were classified as light players, and 34 students (26%) were classified as heavy players. In the second approach, we grouped students according to whether they self-identified as a *nongamer* (8 students, 6%), *casual gamer* (38 students, 29%), or *avid gamer* (83 students, 64%) of any type of game. These two methods of classification allowed us to distinguish between time spent playing video games and personal identification with gaming (Table 2).

Although the vast majority of students had experience playing games recreationally, only 21% (28/132) responding to Survey 1 said they had heard of gamification in education, business, or other contexts prior to the course. Even fewer (5.3%) said they had previously taken a course that was gamified in some way.

2.3 | Procedure

All 144 students enrolled in the course were invited to complete a confidential survey during their small-group lab sections at three points during the course of a 10-week quarter: at the beginning, middle, and end of the course. The surveys asked questions about students' prior knowledge of and experience with gamification; frequency of recreational gameplay; self-identification as a nongamer, casual gamer, or avid gamer; and attitudes toward the course (see Appendices A–C for all survey questions used in the current analysis). Due to varying levels of class attendance, not all students completed all three surveys. One hundred thirty-nine students (97% of total enrolled students) completed at least one survey; 132 students completed survey 1; 115 students completed survey 2; 86 students completed survey 3; and 81 students completed all three surveys.

TABLE 2 Classification of survey respondents according to gaming frequency and self-ascribed gamer identification (N = 129)

	Survey respondents (N = 129)	
Gaming characteristic	***n***	**%**
Gaming Frequency		
Nonplayer (0 hr per week)	15	12
Light player (1–9 hr per week)	80	62
Heavy player (10+ hr per week)	34	26
Gamer identification (self-ascribed)		
Nongamer	8	6
Casual gamer	38	29
Avid gamer	83	64

2.4 | Data analysis

The survey data included a mix of categorical and ordinal variables. The ordinal variables were typically too skewed (and also did not have enough response levels) to satisfy the normality assumption of common statistical tests. Using nonparametric tests for statistical significance allowed us to compare responses across two and three groups while not making normality assumptions about the response variable. For the Mann–Whitney U test (also known as the Wilcoxon rank-sum test), the only assumption is that the groups are independent, and the response data are ordinal (Mann & Whitney, 1947; Wobbrock & Kay, 2016). We therefore used this test in many cases for comparing responses between two groups (e.g., by gender). Similarly, the Kruskal-Wallis test extends these parameters to more than two groups (Kruskal & Wallis, 1952; Wobbrock & Kay, 2016) and was used to compare ordinal data involving more than two groups (such as gaming frequency and gamer identification). For count and other categorical data where the data were not ordinal, we primarily used chi-squared tests, with Fisher's exact test in cases when cell counts were too low for the chi-squared test. For each statistical test performed, we omitted students with incomplete data from our analysis.

To answer RQ1 (What are students' attitudes towards and experiences of a gamified undergraduate course?), we examined changes in students' attitudes towards the gamified format of the course between the beginning and end of the quarter. We also examined students' preferences for taking the course with or without the gamified format, including their open-ended responses explaining their preferences.

To answer RQ2 (To what extent does gamification contribute to students' perceived learning and achievement?), we examined student

responses to survey questions asking whether students thought that gamification supported their learning of the course material, whether they thought gamification made it easier or harder to do well in the course, and whether they thought their grade would be higher or lower without gamification.

To answer RQ3 (To what extent does gamification influence students' engagement in the course material and ideas?), we examined student responses to survey questions asking about students' enjoyment of different gamified activities (e.g., competition and collaboration), as well as their enjoyment and motivation compared to other nongamified courses.

For all three research questions, we investigated whether there were differences according to gaming frequency, gamer identification, and gender.

3 | FINDINGS

3.1 | Students' attitudes towards gamification

Students maintained a positive attitude towards the gamified format of the course between the start and end of the quarter (see Figure 1). At the beginning of the course, 58% (76/132) of student survey respondents said they were generally enthusiastic or very enthusiastic about the gamified format of the course. An additional 23% (30/132) of respondents said they were neutral, 18% (24/132) reported having some doubts, and only 1.5% (2/132) reported having strong doubts. These attitudes remained largely unchanged by the end of the course, where 53% (46/86) of survey respondents said they liked or loved the gamified format, 22% (19/86) said they had no strong opinion, 16% (14/86) said they disliked it, and 8% (7/86) said they hated it.

Fully 76% (87/115) of students said they would prefer the course with gamification. Students were asked to explain their reasoning in an open-ended follow-up question. Fun emerged as a major theme in these responses: "It's fun and interactive which keeps me interested and participating." Similarly, another student commented: "I like it because it makes getting a good grade more fun and it makes it feel a little less like work." In addition, students appreciated the ability to track their progress in the course: "Gamification is something I've never done before, and it's a great way to keep track of how you are doing in a class." Relatedly, students also mentioned the personalized nature of the learning, embodied in the ability to move at one's own pace: "I can move at my own pace while still retaining information and developing my skills in the class." Similarly, another student commented: "Either way assignments need to get done, gamification adds your own pace into the equation." Not all students enjoyed the self-paced nature of gamification: "I'd prefer to have traditional assignments with clear due dates to help me stay on track." Other complaints about the gamified format of the course included technical difficulties with the web-based platform, confusion about how to select and engage in the gamified activities, and fear of falling behind due to a high workload.

When asked whether knowing a course is gamified would influence their decision to enroll in it, 53% of students (46/87) said they would be more likely to enroll, 24% (21/87) said they would be less likely to enroll, and 23% (20/87) said that gamification would have no effect on their decision to enroll.

3.2 | Gamification's perceived influence on student learning and achievement

After examining students' general attitudes towards the gamified format of the course, we looked more specifically at students' perceptions of how gamification impacted their learning, achievement, and levels of engagement in the course. To determine gamification's influence on learning and achievement, we examined student responses to survey questions asking whether students thought that gamification supported their learning of the course material, whether they thought gamification made it easier or harder to do well in the course, and whether they thought their grade would be higher or lower without gamification.

In response to whether they thought the gamified format of the course supported their learning of the course material, 61% of students (53/87) said they thought they learned more with gamification, 23% of students (20/87) said they would have learned more without gamification, and 16% (14/87) said that gamification had no effect on how much they learned. There were no statistically significant differences across gender, gaming frequency, or gamer identification.

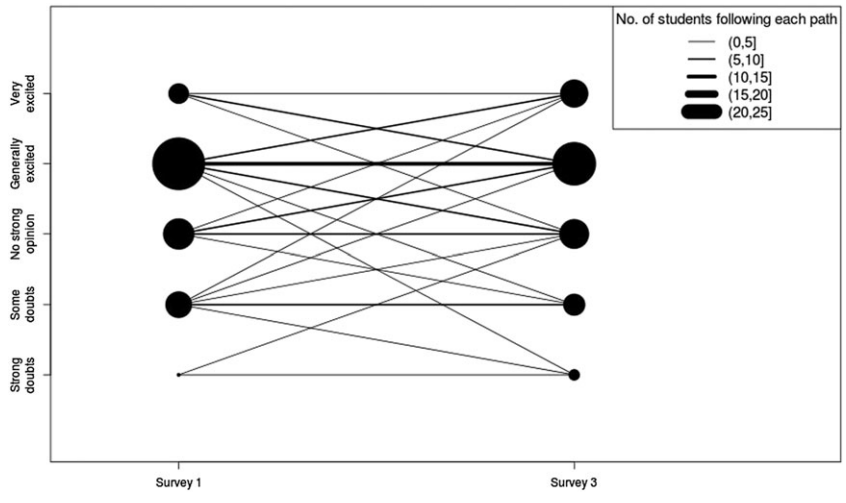

FIGURE 1 Graphic representation of changes in students' attitudes towards the course between Surveys 1 (start of course) and 3 (end of course). The size of the circles and thickness of the lines correspond to the number of students represented (N = 86)

Students were asked to explain their reasoning in an open-ended follow-up question. To explain how gamification helped support learning, one student commented: "I feel like I learned a lot more because I was interested and also the fact that I knew what I had to do in order to do well motivated me to get everything I need done." Another student said: "I liked being able to learn at my own pace and in unique ways." Of the students who felt that gamification did not support their learning, one wrote: "Gamification incentivized doing as much as possible to get points, at a breakneck pace that sacrificed the reflection necessary for learning." In a similar manner, another student commented: "[I] felt like I had to 'jump through the hoops' in order to gain XP [rather] than really learning the material." A student who felt that gamification had no impact on his learning said: "I still treated this as a normal class in that I did my best to learn the material."

Overall, students were most likely to report that gamification made it easier for them to do well in the course (44%, 38/87 students agreed). Only 21% (18/87) said that gamification made it harder to do well. With respect to how gamification impacted their final grade, 41% of students (36/87) thought their grade would be lower without gamification, 22% (19/87) thought their grade would be higher, and 37% (32/87) thought their grade would be the same.

3.3 | Gamification's influence on student engagement

To explore gamification's impact on student engagement, we examined students' responses to survey questions asking about their enjoyment of different gamified activities and experiences, as well as their enjoyment and motivation compared with other nongamified courses. In the midquarter survey, students were asked how much they enjoyed the following four gamified activities:

1. Compete with others in challenges,
2. Collaborate and socialize,
3. Express yourself creatively, and
4. Explore the game world and options.

Collaboration emerged as the most engaging activity, with 61% of respondents (70/115) reporting that they liked or loved it. Competition was the least engaging of the four activities, with only 43% of respondents (49/115) reporting that they liked or loved competing with others. Approximately half of respondents said that they liked or loved the opportunity to express themselves creatively (53%) and to explore the game world (51%).

In an open-ended question, we asked students to identify which gamified experiences they enjoyed most and least. Builders emerged as the most popular format for learning. Students appreciated the hands-on nature of the activities, as well as the opportunity to gain coding skills. For instance, one student commented: "Builders were fun because they were hands on experiences with things." Students were most divided about Learners. Those students who enjoyed these activities the most cited the flexibility afforded by working independently at one's own pace: "I liked the learners because I was able to move at my own pace." Students who disliked Learners said that the fill-in-the-blank quizzes felt like busywork. One student stated: "Learners have no real educational value, they are fill in the blanks that do not engage the learner in any way." At the end of the quarter, students were asked how much they enjoyed the gamified course compared with other nongamified courses at their university. Two thirds of the students (58/87) said they found the course more enjoyable than other courses they had taken at the university, compared with 22% (19/87) who said it was less enjoyable and 11% (10/87) who said they experienced about the same level of enjoyment as other courses. In response to whether they thought that the gamified format made the course more interesting/fun versus more boring, 53% of students (46/87) said that gamification made the course more interesting/fun, whereas only 14% (12/87) said that it made the course more boring.

Students were also asked to reflect on whether they had extra motivation to do well in the gamified course compared with their other nongamified courses. Overall, 48% of students (41/85) said they had extra motivation to do well in the gamified course, 26% (22/85) said they had equal motivation, and 27% (23/85) said they had less motivation.

3.4 | Effects of recreational gaming experiences and gender

We investigated the effects of gamer frequency, gamer identification, and gender on (a) students' attitudes about gamification, (b) gamification's perceived influence on learning and achievement, and (c) gamification's impact on student engagement in the course materials and ideas. Table 3 summarizes the results of these analyses. Overall, there were very few statistically significant effects of the three moderating variables.

The only gender difference that we identified is related to students' perceptions of gamification's impact on their final grade. Gender was significant at the 0.10 level ($Z = 1050.5$, $p = .06$): 33% of male students (19/57) thought their grade would be lower without gamification, compared with 57% of female students who thought their grade would be lower without gamification (17/30). In other words, female students were somewhat more likely to feel that gamification had a positive impact on their course grade.

Our examination of differences in students' enjoyment of various gamified activities revealed a significant difference across gamer identification categories for just one of the activities: exploring the game world ($\chi^2(2, N = 115) = 6.96$, $p = .03$). The difference here was driven primarily by casual gamers' neutral response compared with nongamers and avid gamers, who were generally more enthusiastic about exploring the game world.

With respect to gamification's impact on students' motivation to do well in the course, responses were significantly different across the three categories of gaming frequency ($\chi^2(2, N = 85) = 10.12$, $p < .05$). The difference was driven by the nonplayer category. Fully 70% of nonplayers reported that they had less motivation to do well in the gamified course, and only 20% reported that they had greater motivation (Table 4).

TABLE 3 Summary of results related to the effects of recreational gaming experiences (gaming frequency and gamer identification) and gender on students' attitudes about and experiences with gamification

	Gaming frequency	Gamer identification	Gender
RQ1: Students' attitudes towards gamification			
Attitude towards gamified format	No effect[a]	No effect	No effect
Preference for gamified format	No effect	No effect	No effect
Gamification's influence on decision to enroll in course	No effect	No effect	No effect
RQ2: Gamification's perceived influence on student learning & achievement			
Perceived impact of gamification on learning	No effect	No effect	No effect
Perceived impact of gamification on ability to do well in course	No effect	No effect	No effect
Perceived impact of gamification on final grade	No effect	No effect	Female students somewhat more likely to say gamification had positive impact on final grade*
RQ3: Gamification's impact on student engagement			
Enjoyment of gamified activities	no effect	Nongamers & avid gamers enjoyed exploring game world more than casual gamers**	no effect
Enjoyment of gamified course vs. nongamified courses	No effect	No effect	No effect
Perception that gamification made course more fun vs. more boring	No effect	No effect	No effect
Impact of gamification on motivation to do well in course	Nonplayers reported less motivation to do well vs. light & heavy players**	No effect	No effect

[a]No effect at the $p < .05$ level of statistical significance.

*$p < .10$.

**$p < .05$.

4 | DISCUSSION

The current study adds new insight into the impact of gamification in higher education contexts by exploring students' experiences of a gamified informatics course at three time points during the course. Overall, we found positive trends with respect to students' perceptions of gamification's impact on their learning, achievement, and engagement in the course material. Although students who played and identified variously with recreational games were more alike than not, we did uncover one notable difference with respect to how students' gaming frequency impacted their engagement in the course. In contrast, we found virtually no gender differences. These findings provide new evidence relating to the impact of individual characteristics on students' experiences of gamification. In this section, we discuss our findings in light of extant theory and research related to game-based learning, interest development, and motivation.

TABLE 4 Proportions of nonplayers, light players, and heavy players who reported having less, equal, or more motivation to do well in the gamified course compared to traditional courses ($N = 85$)

	Nonplayer	Light player	Heavy player
Less	(7) 70%	(8) 15%	(7) 30%
Equally	(2) 10%	(14) 27%	(7) 30%
More	(1) 20%	(30) 58%	(9) 39%
Total	(10) 100%	(52) 100%	(23) 100%

Consistent with previous research (see Dicheva et al., 2015), our findings showed that students expressed largely positive attitudes towards the gamified format of the course. Over three quarters of students (76%) said they would prefer the course with gamification, and just over half (53%) said they would be more likely to enroll in a future course if it was gamified. The primary reasons students gave for their positive attitudes related to the fun they experienced through gamification, their ability to track their progress in the course, and the personalized nature of their learning experiences. These reasons align with existing theory describing the potential for gamification to support learning (Gee, 2007, 2008; Plass et al., 2015; Squire, 2008). For instance, the fun that students experienced relates to the motivational and affective perspectives on game-based learning articulated in Plass et al.'s (2015) integrated design framework. The ability to track one's progress in the course also relates to the motivational perspective to the extent that students' agency is supported when they feel in control of their learning. The personalized nature of students' learning experiences relates to Granic et al.'s (2014) discussion of a game's ability to meet players where they are and, in the spirit of Vygotsky and Cole (1978) ZPD, push them just beyond what they are currently capable

of accomplishing on their own. Personalized learning also relates to both the motivational and affective perspectives of Plass et al.'s framework by creating a learning experience that aligns with students' individual values, interests, and capabilities.

Although the personalized nature of the course was generally regarded in a positive light, a minority of students reported difficulty pacing themselves throughout the quarter and a desire for hard deadlines. In order not to impede the learning of other students, we suggest that those students work directly with their instructor or teaching assistant to formulate a plan that provides them the constraints they seek. In this way, learning remains personalized for all students.

In light of the connections between students' overall positive attitudes and existing theory on game-based learning, it is perhaps not surprising that nearly two thirds of students (61%) said they believed they learned more with gamification, compared with only 23% who thought they would have learned more without gamification and 16% who thought that gamification had no impact on their learning. Among the 22% of students who thought they would have learned more without gamification, several complained that the focus on gaining XP, leveling up, and other gamified elements detracted from their learning. This complaint is consistent with critics of gamification, who worry that focusing on external rewards undermines the pursuit of knowledge for its own sake (Toyama, 2015).

With respect to perceived achievement, our results are consistent with prior research showing a positive impact of gamification on student performance and achievement (e.g., Barata et al., 2013; Ibanez et al., 2014). In addition, achievement was the one area in which we found a small difference between male and female students, with female students slightly more likely to say they believed gamification had a positive impact on their final grade in the course. However, this difference was only approaching statistical significance ($Z = 1050.5$, $p = .06$). The absence of major gender differences in our study runs counter to common stereotypes about gender and gaming (Fisher & Jenson, 2016) but supports previous empirical research exploring gender differences in gamification (Fan et al., 2015; Papastergiou, 2009; Plass et al., 2015).

Like achievement, the findings related to student engagement were largely positive. Overall, most students (67%) said they enjoyed the course more than other courses they had previously taken at the university, and they were more likely to say that gamification made the course more interesting/fun (53%) rather than more boring (14%). Students were also more likely to say that gamification gave them extra (48%) rather than less (27%) motivation to do well in the course. These findings are supported by previous research examining the impact of gamification on student engagement and motivation (e.g., Banfield & Wilkerson, 2014; Barata et al., 2013).

With respect to the types of gamified activities that students found most engaging, opportunities for collaboration emerged as considerably more popular than competition with other students (61% vs. 43%). This difference speaks to the sociocultural perspective on game-based learning (Plass et al., 2015), which underscores the social foundations of gameplay. It also supports results from previous studies showing that competition can sometimes have negative effects on student satisfaction and enjoyment (Sepehr & Head, 2013) and undermine sociability within the gamified environment (Ejsing-Dunn & Karoff, 2014). In addition, students were more likely to identify Builders as their favorite learning format. This finding was likely due in part to the fact that so many students (41%, 53/130) were planning to major in computer science, informatics, or engineering.

We also found that nongamers and avid gamers enjoyed exploring the game world more than casual gamers. The novelty of the gamified format may have spurred nongamers' desire to explore the game world. By contrast, the gamified format was likely not particularly novel to avid gamers, but their love of games may have sparked their desire to explore this new game world.

One notable difference in student engagement emerged when we compared responses across categories of gaming frequency. Students who spent no time playing recreational games were considerably less motivated by the gamified format of the course compared with students who were light players (1–9 hr per week) and heavy players (10 or more hours per week). Though the difference was large, it should be noted that a small number of students (12%, or 10/85) said they never played games recreationally. When viewed from the perspective of interest development (Hidi & Renninger, 2006), this finding suggests that gamification may not trigger a situational interest to the same degree for all students. Hidi and Renninger's (2006) four-phase model of interest development underscores the important role that previous experiences and personal interests play in students' willingness to engage in an activity at the outset. In other words, personal relevance is critical to triggering a situational interest. Students who do not play games may be less open to and motivated by gamified experiences. For these students, it may be more difficult to trigger a situational interest, which in turn poses challenges to their development of a maintained situational interest and, eventually, a well-developed individual interest in a domain of learning. Although this explanation is certainly plausible in light of extant theory, it is important to note that, in the current study, differences emerged between gamers and nongamers for only one of several measures of engagement. Overall, nongamers appeared to be equally engaged by the gamified format of the course as gamers.

4.1 | Limitations and future directions

A strength of this study is its elicitation of students' perspectives on gamification at three different time points during the course of an academic quarter. We were able to assess students' preconceptions of gamification as they started the course, their experiences while engaging in the course material, and their reflections on their experiences at the end of the course. These data provide a detailed look at students' subjective experiences of gamification, with a focus on their perceived levels of engagement, learning, and achievement. In light of the limitations associated with such attitudinal measures, however, future work should incorporate objective measures of student engagement and performance, such as participation on the course website, performance on assignments, and final grades. In addition, we did not track students' choice of activities during the course (i.e., Learner, Builder, Thinker, and Speaker). As a result, we were unable to address the question of whether the specific combination of activities that students chose influenced their experience of the course. This is another avenue for future research.

The students who enroll in an informatics course focused on social networking technologies presumably have some level of interest in—and knowledge of—networked technologies. It is possible that such students may be more open to trying out new pedagogical approaches that leverage networked technologies. Future research should explore how gamification is received and experienced by students enrolled in different types of courses, such as humanities, life science, and social science courses. Such research would provide valuable insight into the conditions under which gamification succeeds or fails in higher education.

5 | CONCLUSION

As interest in game-based learning grows, it becomes increasingly important to explore the extent to which gamified approaches to education succeed at engaging students and supporting their learning. The current study contributes insight into this question by investigating students' perceptions of the impact of gamification on their engagement, learning, and achievement in an undergraduate informatics course. Through our analyses of survey data collected from students enrolled in the course, we found that students generally responded positively to the gamified format of the course. The frequency with which students played recreational games had some impact on their levels of engagement in the course, with nongamers expressing somewhat less motivation to do well in the course than students who played games frequently. For all other measures of engagement, however, nongamers appeared to be equally engaged by the gamified format of the course as gamers. There were virtually no differences between male and female students' perceptions of the gamified format of the course. These findings hold implications for designers and instructors of gamified learning environments seeking to engage diverse students.

ORCID

K. Davis http://orcid.org/0000-0001-8794-8651

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APPENDIX A.

SURVEY 1: QUESTIONS USED IN ANALYSIS

1. Prior to this course, had you ever heard about the concept of gamification in education?

   □ Yes.
   □ No.

2. Prior to this course, had you ever taken a class that was gamified in some way (e.g., points, leaderboards, leveling up)?

   □ Yes.
   □ No.

3. What is your opinion of the gamified format of the course (XP, leaderboards, achievements)?

   □ I have strong doubts.
   □ I have some doubts.
   □ No strong opinion.
   □ I'm generally enthusiastic/excited.
   □ I'm very enthusiastic/excited.

4. Which type of video games do you play? (check all that apply)

Game Type	Casual Player	Avid/Frequent Player
Action-Adventure (The Legend Of Zelda, Prince of Persia, GTA, Destiny)		
Adventure (Sly Cooper, Harry Potter series, Fantasy, Bugs Life)		
Arcade (Pac-man, Donkey Kong, Asteroids, Dig Dug)		
Driving/racing (Mario Cart, Moto GP)		
Fighting (Street Fighter, Mortal Kombat)		
Music/Dance (Guitar Hero, Dance Dance Revolution)		
Puzzle (Candy Crush, Tetris)		
Role-playing (MMORPG) (World of Warcraft, Final Fantasy)		
First-person Shooter (Call of Duty, Counter Strike)		
Simulation (Farmville, Sim City)		
Sports (FIFA, Madden NFL, NBA)		
Strategy (Starcraft, Total War series, Age of Empires)		

5. How many hours in a typical day do you spend playing games?
6. Year in College

   □ Freshman
   □ Sophomore
   □ Junior
   □ Senior

7. Age
8. Gender

   □ Male
   □ Female
   □ Do not wish to disclose

APPENDIX B.

SURVEY 2: QUESTIONS USED IN ANALYSIS

1. Would you prefer to do INFO 101 with or without Gamification?

   □ I'd prefer INFO 101 WITH Gamification
   □ I'd prefer INFO 101 WITHOUT Gamification

2. Please explain briefly the reasoning behind your answer for question 1.
3. How much do you like doing the following in INFO 101?

   Compete with others in challenges
   Collaborate and socialize
   Express yourself creatively
   Explore the game world and options
   □ Hate it

- ☐ Dislike it
- ☐ No strong opinion
- ☐ Like it
- ☐ Love it

APPENDIX C.

SURVEY 3: QUESTIONS USED IN ANALYSIS

1. What is your current opinion of the Gamified format of the course?

   - ☐ I hate it
   - ☐ I dislike it
   - ☐ No strong opinion
   - ☐ I like it
   - ☐ I love it

2. Do you feel that gamification supported your learning of course material?

   - ☐ I think I learned more WITH Gamfication
   - ☐ I think I would have learned more WITHOUT Gamification
   - ☐ Gamification had no effect on how much I learned

3. Please explain briefly your answer choice for question 2.
4. Compared to other courses you have taken at this university, how much did you enjoy the assignments and activities in INFO 101?

   - ☐ INFO 101 is much more enjoyable
   - ☐ INFO 101 is somehwat more enjoyable
   - ☐ INFO 101 is about the same level of enjoyment as other classes
   - ☐ INFO 101 is somewhat less enjoyable
   - ☐ INFO 101 is a lot less enjoyable

5. Did you have extra motivation to do well in this course compared to traditional courses?

   - ☐ I was more motivated than traditional courses
   - ☐ I was less motivated than traditional courses
   - ☐ I was equally motivated in both cases

6. How did the gamified format of the course impact your experience of it? (Check all that apPLY)

   - ☐ It made it more INTERESTING/FUN
   - ☐ It made it EASIER to do well
   - ☐ It had NO IMPACT on my experience
   - ☐ It made it HARDER to do well
   - ☐ It made it more BORING

7. Do you think your grade would be higher or lower if the course was not Gamified?

   - ☐ My grade would have been HIGHER without Gamification
   - ☐ My grade would have been LOWER without Gamification
   - ☐ No difference

8. In the future, how will knowing a course is “gamified” influence your decision to enroll in it?

   - ☐ I will be more likely to enroll
   - ☐ I will be less likely to enroll.
   - ☐ It will have no effect on my decision to enroll