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How does a Gamification Design Influence Students' Interaction in an Online Course?

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Abstract

This study created and examined a gamification design that aimed at improving students' interaction in a graduate level online course. By using a design-based research approach, the study investigated the application of principles from Self-Determination Theory in the gamification design and its influence on students' interaction in discussion forums in terms of quantity, interaction dynamic, and interaction quality. The gamification design included a positive feedback system, contextualized in a narrative environment that was based on the original course project design. Participants were 49 students enrolled in the online course in three versions of the course, which were the non-gamification version of the course in the 2016 summer semester (NGC), the prototype gamification version of the course in the 2016 summer semester (PGC), and the revised gamification version of the course in the 2016 summer semester (RGC). Students' interaction data in the academic discussion forums were compared with each other. Students' gamification performance data were presented and compared between the PGC and the RGC. Moreover, eight students from the RGC participated in semi-structured interviews and shared their experiences and perspectives about the revised gamification design.

The results showed that students in the gamified courses posted more messages per week. When students were the facilitators for the week, they were more actively involved in the online discussion. The student facilitators in the gamified courses were more active compared to the student facilitators in the non-gamified course. Second, students' interaction was more evenly distributed among students in the gamified courses. On average, students in the gamified courses received comments from more peers than students in the non-gamified course. The class level density scores were higher with smaller centralization scores in the gamified courses. Finally, the RGC discussion transcripts presented more knowledge building features on a weekly basis in

comparison with the PGC and the NGC, while overall the online discussion in the three versions of the course fell into the lower phases in the knowledge building conceptual model.

Students' gamification performance was about the same in the two gamified courses. Nonetheless, the design adjustments made between the two design cycles and during the second cycle improved students' participation in several gamification activities. Furthermore, students' interaction was more stable during the six weeks in the RGC due to the design adjustments.

The semi-structured interviews further revealed the RGC interviewees' experiences in the course. The positive feedback system satisfied students' competence needs. Nonetheless, to what degree their competence needs were satisfied depended on their experiences and understanding of gamification. In pursuit of competence needs, some interviewees' autonomy needs were undermined. The peer evaluation, dynamic academic discussion, and the authentic course project satisfied students' relatedness needs. But additional emotional support from peers was barely sufficient.

The study provided an example of gamification design in online courses to improve students' interactions in discussion forums. The results suggested a positive feedback system could be added in the course design to improve students' performance of the targeted learning activities. The selection of learning activities, the design and development of the gamification elements, and the gamification algorithm should take both the subject matter and students' characteristics into consideration. A narrative environment can help align the feedback system with the course context and students' actions should result in development of the narrative.

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Chapter 1 Introduction

Online learning has been growing rapidly in the last two decades (Allen & Seaman, 2015). According to Allen and Seaman's annual reports on online education (2015, 2016, 2017), in 2014, more than 28% post-secondary students have taken at least one online course, compared with 9.6% in 2002. Particularly, as of 2014, one in seven students has enrolled in a fully online program. Online courses have been widely offered by higher education systems, not only credit courses and degree programs but also Massive Open Online Courses (MOOCs). Allen and Seaman's report (2016) showed that in 2015, 11.3% of higher education institutions had a MOOC. Even though the growth in online education has slowed in recent years, it will continue to grow faster than traditional classes (Nash, 2015).

As a result, the quality of online learning becomes especially important to academic leaders, instructors, students, and parents. Online Learning Consortium (2016) proposes five key important areas when determining the quality of online learning, including learning effectiveness, scale, access, faculty satisfaction, and student satisfaction. Among the five building blocks, Students-students interaction plays a critical role for both learning effectiveness (Kurucay & Inan, 2017) and students' satisfaction (Luo, Zhang, & Qi, 2017).

Students' interaction is a major component of learning in online courses. Scardamalia and Bereiter (2006) discussed the shortcomings of knowledge transmission, which has dominated the classroom teaching for a long time. They proposed to shift the learning activity design from a didactic approach to a knowledge building approach, which focuses more on students' active role in learning. Students' interaction is an integral part in the knowledge building pedagogy (Scardamalia & Bereiter, 2006). At the same time, with the advancement of information technology, online learning platforms make students' interaction possible and easy to access.

Common tools for students' interaction in online courses (e.g., emails, blogs, online forums, and audio/video conferencing) bring additional channels for students to communicate and learn from each other. Among all the communication tools, the online discussion forum becomes a common choice in most online courses (Hou, 2012). Students are given equal opportunities to contribute and share thoughts via online discussion forums, which provide students space to develop understanding and to negotiate meaning within the class (Larreamendy-Joerns & Leinhardt, 2006). Compared to reading and watching the learning materials assigned by the instructor passively, online activities involving students' interaction create opportunities for students to articulate their ideas (Bain, 2011). By composing a message, students are expected to organize their own thoughts about the topic and to write them logically. Meanwhile, reading others' posts requires students to bring their own knowledge to decode the meaning (Wertsch & Toma, 1995). The pedagogy shift and technology growth makes students' interaction fundamental to online learning effectiveness.

Additionally, students' interaction plays an important role in building a sense of community, which is related to their satisfaction with the course (Shackelford, 2012). Students' perception of learning from each other contributes to the development of a sense of community (Rovai, 2002). Becoming a part of a supportive community improves students' satisfaction with online learning. Furthermore, such a supportive class community may mitigate attrition (Rovai, 2007). Students in online courses are mostly physically isolated. They are separated from teachers and other classmates, and might feel disconnected and helpless. Therefore, persistence is hard to achieve. For courses that students cannot drop, they may choose to disengage. The social aspect of students' interaction helps them to pursue connections among each other. Appropriate students' interaction can help develop a class community, thus alleviates the psychological separation (Rovai, 2002), and provides students emotional support (Rovai, 2007). As a result, students can have a better online learning experience.

In summary, students' interaction is crucial to a positive online learning environment. It is not only related to students' learning achievement but also influences their satisfaction with the courses. On top of that, through students' interaction, a class learning community can develop and help to provide students with a quality learning experience.

Problem of Students' Interaction in Online Courses

Though students' interaction plays a critical role in online courses, it does not always lead to the best possible learning outcomes (Joubert & Wishart, 2012). Students' interaction does not occur spontaneously with the presence of computer-mediated communication tools provided by online courses. For example, a case study in two online courses showed that the number of posts decreased after the first couple of weeks (Nandi, Hamilton, & Harland, 2012). Moreover, the online discussion is always dominated by a few people, and the majority do not contribute any messages (Romiszowski & Mason, 2004). Previous researchers pictured different types of online learners. One is "Lurkers" (Romiszowski & Mason, 2004), who are also called "Listeners" (Wise, Hsiao, Marbouti, Speer, & Perera, 2012) or "Browsers" (Salmon, 2003). The lurkers, listeners, and browsers are the type of students who log in and possibly read the messages posted on the discussion forum, but do not contribute ideas to the topic of discussion. Some researchers argue that learning may occur when lurkers are inspired by ideas shared on the forum (Guzdial & Caroll, 2002). The other type of learners is students who are highly interactive with peers. Most students fall between these two extreme ends.

Besides the varying participation levels in online classes, the quality of the messages students post is another common concern among online educators and researchers. Messages in online discussion forums are always considered in the lower order thinking range in research studies applying Bloom’s taxonomy (Darabi, 2013). Moreover, Lucas, Gunawardena, and Moreira (2014) reviewed research studies adopting the Interaction Analysis Model (Gunawardena, Lowe, & Anderson, 1997), a widely used model for knowledge construction in computer-mediated communication contexts, and found that in most studies, students’ interaction falls in Phase 1 of the model: sharing and comparing information. Students’ interaction in the higher phases of the model is rarely found in the discussion forums.

Therefore, the two major issues with students’ interaction in online discussion forums are the various participation levels, which lead to a centralized interaction pattern, and the low quality interaction that is detrimental to information flow. One possible reason for the two problems of interaction is that students tend to fulfill the minimum requirement: once the minimum requirement is met, they stop pursuing higher goals. Peters and Hewitt (2010) interviewed ten students who were taking or had taken online courses about their experiences and practices developed in the course they took. Based on the interviews, they distributed a survey to examine the commonalities of these practices across a student population. 57 students from six online courses responded. They concluded that strategies frequently used by students are not driven by learning but by merely meeting the course requirement. In a more recent study, Beckmann and Weber (2016) found a similar pattern. Students’ participation in the online discussion forum is not due to interests but to fulfilling the task.

These findings reflect students’ coping strategies in online courses, but they also question the legitimacy of the minimum requirement design in online discussion forums from students’ perspectives. If the goal of students participating in discussion forums is for the sake of a participation grade instead of communicating and sharing, it is not surprising that the quality of messages posted in online discussion forums is disappointing. After all, participation is a necessary but not sufficient condition for high quality discussion (Naranjo, Onrubia & Segués, 2012). Composing messages with a perfunctory attitude will lead to low quality messages and eventually keep the benefits of interaction out of reach of students. When meaningful conversation and interaction have less chance to occur, higher order thinking skills, such as reflection and knowledge building, also have a lower chance of happening. Therefore, the more serious problem raised by Peters and Hewitt's study is: how can online discussion activities where meaningful interaction occurs and learning happens be designed so students do not give earning grades a higher priority over learning.

Many research studies have been conducted to improve issues of students' interaction in online learning environments. Researchers have adopted learning analytics to develop visualization tools for teachers to understand students' performance (Calvani, Fini, Molino, & Ranieri, 2010; Van Leeuwen, 2015). For example, Calvani et al. (2010) developed tools to inform tutors of students' interaction dynamic in discussion forums in order to help the tutors take actions to intervene. These studies focus on the teacher-regulation perspective—developing strategies and tools to help teachers monitor and support students' interaction (Chen, 2015). Additionally, other researchers choose to develop a learning environment that provides additional affordance for students to better interact with peers (Scardamalia & Bereiter, 2006; Marbouti & Wise, 2016). For example, Marbouti and Wise (2016) transformed the threaded online discussion forum into a net view in order to gain students' attention to each other's posts. Instead of developing learning environments, some researchers innovated the design of the online discussion activity. One common intervention is adding motivation design to engage students in interaction (Rovai, 2007; Brewer & Klein, 2004; Xia, Fielder, & Siragusa, 2013). For example, students played roles as facilitators, responders, and synthesizers to share the responsibilities of maintaining an active discussion thread with instructors (Zha & Ottendorfer, 2011; Xie, Yu, & Bradshaw, 2014). This approach empowers students by giving them control of collaboration. The other type of role-playing is students play real world roles to solve an authentic problem. Such design makes the discussion activity more meaningful and more relevant to the real world where students apply the knowledge (Hou, 2011; Hou, 2012).

The studies described above do improve students' interaction in online discussion. However, due to the technology barrier and the high cost, it is not possible for some designers and instructors to develop a new learning environment. Adopting motivation design in an online discussion forum is a more cost-efficient choice. Strategies such as role-playing within an authentic problem-solving scenario make the discussion activity more meaningful and more relevant to students' future work. But such designs are often implemented with the discussion activities rather than transforming students' online learning experience holistically.

Gamification design as an emerging motivation design method is a new approach to improve students' participation in online learning (Looyestyn et al., 2017). For example, gamification designers created narrative environments for online courses, placing students in a practical field where the goal of learning was becoming the heroes whose behaviors matter in the gamified course world (Ramirez & Squire, 2014). In this study, I proposed gamification as one attempt to make online discussions appealing and meaningful.

Gamification in Education

Researchers have discussed educational values and potential in video games over the past two decades (Gee, 2003; Habgood & Ainsworth, 2011; Dickey, 2007). Games are an appropriate medium for problem-based learning, experiential learning and so on (Oksanen, Lainema &

Hämäläinen, 2017). Many successful commercial games demonstrate their capacity to create an original world and to have people play various roles to solve problems and develop skills. Nowadays, higher-level understanding is particularly valued, and games are believed to be good at offering cognitive and affective outcomes (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). *Quest Atlantis* (Barab & Duffy, 2012) is one educational game where students play as scientists to solve mysterious issues in order to improve the quality of citizen life in the game world. The designers turned traditional learning activities into challenges embedded in the Atlantis world (Barab & Duffy, 2012). By performing these activities, students practiced scientific inquiries, reasoning, and argumentation skills (Ramirez & Squire, 2014). From a situated learning perspective, one advantage of games is they create experiences where learners use knowledge to solve problems in authentic situations, as contrasted with listening to lectures in classrooms. Furthermore, the authenticity in games enables learners' choices and actions to impact the game world, and these influences are perceived by learners through in-time feedback. Accordingly, students' behaviors in a well-designed educational game world are meaningful. When students are willing to engage in the educational games, learning has a chance to occur (Barab & Duffy, 2011). In addition to educational games, integrating games into learning activities is another attempt to take advantage of games.

Though games have potential in education, the cost of designing and developing a game is high. Gamification is one emerging alternative approach. Instead of developing or selecting a game to play, gamification uses game elements in a non-game context (Deterding, Dixon, Khaled, & Nacke, 2011). Gamification is successful in the service industry, with examples in streaming services and physical exercise applications. It adopts game design to provide users game-like and social experiences in order to affect users' motivation of the behaviors that were expected by the service providers (Hamari & Koivisto, 2013).

Recently, adopting gamification design to improve motivation of participation has started to occur in the educational field. Libraries employ gamification to encourage college students to use the library more frequently and to engage in academic activities (Nah, Zeng, Telaprolu, Ayyappa, & Eschenbrenner, 2014). Online learning websites, such as Khan Academy, employ gamification in the learning system to motivate persistence (Morrison & DiSalvo, 2014). Several gamification features used in Khan Academy's courses are Knowledge Map, Badges, Energy Points, Goals and Progress Indicators. All these features are designed to align with certain motivation processes, including goal setting, outcome expectation, value, and social comparison (Morrison & DiSalvo, 2014). Another example is the website development application *DevHub* (www.devhub.com). It rewards users with points and badges when the learners progress in acquiring web developing skills (Nah et al., 2014).

In addition to the informal learning environments mentioned above, gamification design is also used in formal learning environments. Learning management systems, such as *ClassCraft*, are developed for teachers to adapt gamification in their own classrooms. In *ClassCraft*, the teacher is the game master, and students play different types of roles with different "skill sets". The teacher can set up classroom rules and build a Quest Map for specific learning content. Students win or lose points based on their participation and performance. One case study (Sanchez, Young, & Jouneau-Sion, 2017) reported that teachers have sensed increased motivation and engagement in the classroom when using *ClassCraft*. Lee Sheldon, in his book *The Multiplayer Classroom Designing Coursework as a Game* (2012), documented several case studies of how he and other teachers and/or instructional designers gamified their courses.

Students in Sheldon's game design class usually began as a level one avatar, but by participating in group or individual activities, they earned experience points and leveled up. Their final experience points decided their letter grades.

A recent review of online programs in higher education with a specific focus on gamification showed positive results (Looyestyn et al., 2017); 12 out of 15 experimental studies have found positive influences of gamification in terms of direct engagement and related learning outcomes. Effect sizes range from medium to large. The most common gamification features used in these studies are leaderboard, badge, points, and rewards. Among all these features, leaderboard is a particularly effective gamification approach.

Overall, the use of gamification in the educational field is growing. The common purpose of using gamification in education is to improve learners' motivation to participate in the learning activities, and it is expected that participation can contribute to better learning outcomes. In the next section, I briefly discuss the rationale of gamification's potential to improve students' motivation of participation, and introduced implications from game design features that attract players over the long term.

Game, Gamification, and Motivation Design

People hold different point of views when discussing the reasons for games' motivational pull. Game designers account games' attractiveness for the various choices that players can make (Burgun, 2013). Some researchers believe it is the violence component that attracts people to play (Gentile & Anderson, 2003). Rather than speculating which game features attract people most, Ryan, Rigby and Przybylski (2006) studied the psychological mechanism of the enjoyment from gaming and the reasons of games' motivational pull. Their findings provide a theoretical perspective for selecting and designing game elements in educational contexts.

Ryan et al. (2006) used Self-Determination Theory as the theoretical framework to examine the motivational pull of video games. By analyzing gamers' playing experience data, they found that when a game fulfills people's three basic psychological needs, autonomy, competence, and relatedness, the game engages players in the long term. Autonomy refers to "a sense of volition or willingness when doing a task" (p. 3). People usually play games of their own volition. The design of games provides players plenty of choices. This autonomy is one factor that accounts for enjoyment within games. Competence refers to "need for challenge and feelings of effectance" (p. 3). A well-designed game provides players ongoing challenges to achieve successes. At the same time, games prepare players to win from easier challenges to increasingly difficult challenges with a positive feedback loop. Therefore, it fosters feelings of competence and thus keeps engaging players to put time, energy, and money to achieve better outcomes. Lastly, relatedness "is experienced when a person feels connected with others" (p. 4). In Massively Multiplayer Online Games, players get the chance to interact with other players. Through teaming up with other players, relatedness is fulfilled and leads to persistence in gaming.

In short, Ryan et al. (2006) claimed that whether a game fulfills players' needs of competence, autonomy, and relatedness could predict players' enjoyment and sustaining of game engagement. This indicates that when using game elements to improve motivation in educational contexts, the selected game elements should be designed to satisfy learners' competence, autonomy and relatedness needs.

Rigby and Przybylski (2009) described a specific type of game design method in the educational context. Though their discussion focuses on designing virtual worlds for learning, the idea inspires gamification design in online courses. They propose a concept called "Learner

Hero," picturing learners as heroes in Adventure Games. Through exploring the virtual world, Learner Heroes find their own path (autonomy). During the process, they conquer challenges and quests (competence), and form an alliance with other heroes (relatedness). In such a way, the hero role best exemplified the self-determined functioning of games.

Likewise, Dickey (2007) shared a similar perspective in her analysis of how the design of modern video games fosters intrinsic motivation. Her analysis specifically focuses on Massively Multiplayer Online Role-Playing Games (MMORPGs). The two major elements of this game genre based on her analysis are character design and narrative environment. Players spend time on building characters or avatars because they love to explore, expand and experiment with their characters in a safe gaming environment. Moreover, by interacting with other players' characters in the game, they build social capital with their digital avatars, which became their assets for future tasks and challenges. Secondly, Dickey (2007) pointed out that the highly individualized narratives are another valuable feature in MMORPGs. Players often have their own storylines based on their own choices. They can also contribute to other players' narrative through being allies or enemies. Quests and challenges are an integral part of the narrative environment. By pursuing the quests, players level up their characters, collaborate with other players, explore the world map, and create their own story.

Both analyses on gaming (Rigby & Przybylski, 2009; Dickey, 2007) discussed similar game design features that are related to motivation. These design techniques have already been used in *ClassCraft* and several cases documented in Sheldon's book (2012). For example, in Sheldon's game character design class (2012), students chose avatars and created backstories of the avatar when the class began. The course was turned into a fictional land where students played and also helped to create. The messages students received about the following major instruction components were combined with the backstories. As the instruction moved forward, students were more involved in the narratives. In this gamification case, it is the narrative that gives concrete meaning to the frequently used game features, such as points, badges and leaderboard, and makes them become meaningful indicators for students' learning progress. These discussions and examples show the concept of using gamification to situate learners in a complicated, real-world-like environment (Ramirez & Squire, 2014). Employing design techniques such as role-playing and narrative environment, gamification can transform a learning environment to a practice field where students can learn knowledge through performing authentic tasks. Ramirez and Squire (2014) named this type of gamification design as "learning through narratives and quest" (p. 643).

The success of gamification design in the service industry shows its capacity and potential as a new type of motivation design that maintains users' loyalty to the service (Huotari & Hamari, 2012). Motivation also plays a critical role in learning; motivation design can make quality instruction more appealing to students (Keller, 2009). When using gamification in educational fields to advance learning, which is a more complex process compared to the service industry, the above research and design cases show an encouraging future. Ryan et al.'s (2006) analysis on the mechanism of games provides gamification researchers a design framework when replicating the games' attractiveness to players to online learning environments. Ramirez and Squire's (2014) argument sheds light on the importance of narratives to ensure learning happens in gamified courses. Therefore, the gamification design in this study followed the suggestions from both theoretical perspectives with the intention to improve students' interaction in online courses.

Research Purpose and Questions

This study applied a design-based research approach, conducting two design iterations to examine the effectiveness of gamification design on students' interaction in online discussion forums of online courses. Students' interaction in the non-gamification version of the course (NGC, in 2016 summer semester) was used as the baseline to compare with students' interaction in the gamified courses. The prototype gamification version of the course (PGC) was implemented in the 2017 summer semester. The revised gamification version of the course (RGC) was implemented in the 2018 summer semester. Students' interaction will be evaluated in three aspects: quantity, interaction dynamic, and quality of interaction. Measures selected for the three dimensions of interaction was introduced in the method chapter. Furthermore, semi-structured interviews were conducted at the end of the RGC in order to further validate the theoretical conjectures of the gamification design and its influences on students' interaction.

The specific research questions are:

RQ1. What are the patterns of students' interaction in the online discussion forum of the gamified courses in terms of quantity, interaction dynamic, and interaction quality?

a) How frequently do students post in the discussion forum of the course?
b) What is students' interaction dynamic in terms of Social Network Analysis (SNA) measures?
c) What is the distribution of the knowledge building phases of students' discussion?

RQ2. Compared to the baseline year (the non-gamification version of the course), does students' interaction in the online discussion forum changes in terms of a). quantity, b). interaction dynamic, and c). interaction quality?

RQ3. How does gamification design influence students' interaction in the discussion forums?

a) Are there specific gamification events (points update, leaderboard update, etc.) that influence students' interaction performance?

b) What is the variation among students' interaction under the influences of each gamification event?

Abbreviation List

DBR: Design-Based Research

IAM: Interaction Analysis Model

LSA: Lag Sequential Analysis

NGC: Non-Gamification Course

PBL: Points, Badges, and Leaderboard

PENS: Playing Experience of Need Satisfaction

PGC: Prototype Gamification Course

RGC: Revised Gamification Course

SDT: Self-Determination Theory

Chapter 2 Literature Review

Students' Interaction in Online Courses

Definition of Interaction in Online Courses

One frequently quoted definition of interaction in distance learning, written by Wagner in 1996, is: "reciprocal events that require at least two objects and two actions" (p. 8). The two objects in the definition can be both source and destination of information. By distinguishing the objects of interaction, Moore (1989) identified three types of interaction, which are learner-teacher, learner-learner, and learner-content. Later on, with the development of technology, Hillman, Willis, and Gunawardena (1994) added a fourth type of interaction in the context of online learning: learner and interface interaction. Hillman and colleagues (1994) pointed out that learners' skills of using an interface (of learning management systems or other platforms) to retrieve and post information take mental resources as well, and these operations can take up a large portion of mental resources for other types of interaction. For the first-time users of any online learning environment, the unfamiliarity of operating an interface can contribute the learning curve.

The above classification of interaction focuses on the objects of interaction. By distinguishing the actions within an interaction in online learning, interaction can be categorized as learning related interaction and social related interaction (Roblyer & Wiencke, 2003; Rovai, 2002). The information exchanged between interaction objects can be either learning content or social connections. Particularly, Rovai (2002) believed social connection among students is built through learner-learner interaction. Even though such social interaction is not directly related to the subject matter, a social, friendly environment is beneficial to learning outcomes eventually.

In practice, there are other factors defining interaction in online courses (Holden & Westfall, 2006). Depending on the online learning environment, interaction can be either asynchronous or synchronous. As the time lag is longer in asynchronous environments, maintaining conversations faces more barriers.

Additionally, interaction can be symmetrical or asymmetrical (Holden & Westfall, 2006). For example, for learner-content interaction in which no interactive activities are embedded, it is a one-way communication. The changing in students' learning (if it happens) is intrapersonal. While learner-learner interaction and learner-teacher interaction are symmetrical and interpersonal processes, learning outcomes are externalized through the text, audio or video communication (Holden & Westfall, 2006). Ideally, a symmetrical interaction should be a closed information loop, which is one defining characteristics of interaction claimed by Yacci (2000). Specifically, the loop should start from a student's point of view, which means that only when a student sends out a message and receives a response, is the interaction a completed loop. However, due to the asynchronous nature of online discussion forums, the asymmetrical interaction occurs more often so that the student who initiates a conversation does not always get a response from peer or the instructor. Yacci (2000) recognized coherence as another important characteristic of interaction, meaning on top of a symmetrical interaction, the content that two objects interact about should also be relevant to each other.

With all the discussion of defining interaction in online learning, this study focused on students' interaction in an asynchronous discussion forum in an online course. By Moore's (1989) definition, students' interaction is interactions happening among students with or without teacher presence, in pairs or in groups. More specifically, students' interaction in this study is limited to interaction in the asynchronous online discussion forums of the targeted online course.

Importance of Students' Interaction to Learning

Students' interaction has been recognized as an important factor in face-to-face learning environments for a long time (Johnson & Johnson, 1981). Webb (1982) proposed two hypotheses of the mechanism between learning and interaction. First, from a cognitive process perspective, students verbalize information during interaction with peers, which can produce better performance. Additionally, feedback and resource sharing among peers also influences student learning positively. The second hypothesis is from an emotional perspective. Webb (1982) proposed that socioemotional variables, such as motivation, anxiety, and satisfaction, mediate the effect of interaction on learning.

In online learning environments, students' interaction presents a positive influence on learning. Bernard et al.'s (2009) meta-analysis on the effects of interaction on learning showed that leaners' interaction adds more value to learning outcomes compared to learner-teacher interaction, and was equal to leaner-content interaction. In the following section, I discussed the importance of students' interaction in online courses from both learning and social perspectives.

From information transmission to knowledge building discourse. Verbalizing information is one of the possible mechanisms that explains the connection between students' interaction and learning outcomes. Webb (1982) pointed out that the purpose of verbalizing is important to learning in a face-to-face classroom. Specifically, when students verbalized information to teach peers, they considered themselves as teachers. When playing the teacher role, students have to help others to understand the content, so they need to reorganize the materials and verbalize it as clearly as possible.

Similarly, in online discussions, students express their thoughts to peers in written text. Bain (2011) believed that articulation is the key to students' interaction in online learning. By composing a message, a student is expected to organize her/his own thoughts about the topic, writing it in a logical way. Moreover, from a social constructivism perspective, the written text does not only transmit information, it also requires readers to bring their own knowledge to decode the meaning (Wertsch & Toma, 1995). Therefore, the information recipient plays an active role, either being inspired by the message to generate new understandings or disagreeing with the message, leading to reflection on their original thoughts. As the written conversation continues, students' understanding of the topic may change and develop. As a result, students collaboratively move their understanding of the topic forwards.

Beyond the online discussion context, such a knowledge advancement path also explains the nature of knowledge growth in most disciplines (Scardamalia & Bereiter, 1994). In fact, it is the course of knowledge growth in science fields that inspires the idea of knowledge-building pedagogy in education. In the early 90s, Scardamalia and Bereiter (1994) proposed that school should reproduce the knowledge building process in classrooms by using the help of technology. They described this approach as a third way of schooling, in addition to the didactic teaching and the individual level inquiry-based learning. In a knowledge building learning environment, students engaged in discourse with peers as scientists and researchers, and advanced knowledge together.

The knowledge building discourse Scardamalia and Bereiter (1994) described requires a higher quality level of students' interaction. First, the discourse between students should focus on problems and an in-depth understanding, instead of oversimplified discussions on a general subject topic. Second, the knowledge building discourse should be decentralized. Rather than acquiring knowledge from one teacher or one expert, all the students, even novices, should join the conversation. By bringing different perspectives on the same problem, collective understanding can be generated. Last, Scardamalia and Bereiter (1994) believed that people outside the knowledge building community should be invited to participate in the conversation to contribute critiques and suggestions, so that members could reflect on the topic through making responses.

Sense of community. Even though learning from distance provides more choices of time and location for people, online students frequently feel disconnected from teachers and peers (Slagter van Tryon & Bishop, 2009). The feeling of disconnectedness is one of the reasons that leads to the high dropout rates in online education (Ivankova & Stick, 2007, as cited in Hart, 2012). Studies show that a sense of community can help compensate the feelings of isolation (McInnerney & Roberts, 2004); therefore, it is in association with students' retention and persistence. From a social perspective, the connectedness between students can help increase their satisfaction of learning from a distance and improve the chances of persistence (Rovai, 2002b). Students with strong social connections to classmates are able to seek and receive help and encouragement to persist (Hart, 2012). Meanwhile, a sense of community is also found in association with perceived learning and learning outcomes (Liu, Magjuka, Bonk, & Lee, 2007; Shackelford & Maxwell, 2012; Sher, 2009). In addition to reinforcing social connections between students, a sense of community also helps exchange information. Studies find some students have assumptions that if they bring their own culture's experiences to discussion, they can be misunderstood and would not fit in (Phirangee, Epp, & Hewitt, 2016). Strong feelings of community may help mitigate this culture exclusion, as students trust each other (Rovai, 2002b). Therefore, it improves the flow of information among all learners (Rovai, 2001). Various perspectives from students on the course content can benefit everyone who joins in the class-level communication. In such an environment, students can compare and contrast each other's understanding, assimilating knowledges from both teachers and peers.

Rovai (2001) believed that interaction is an important component of classroom community in online courses, which brings feelings of closeness and mutual benefits. In his case study of a 5-week online course, students' sense of community increases. He explained the increase could be due to the interaction and involvement in the online course that alleviates students' psychological distance. Students' interaction positively relates to their sense of membership, which is one of the dimensions of the sense of community (Luo, Zhang, & Qi, 2017). Therefore, students' interaction in online classes can strengthen a sense of community. Online instructors and designers should supply sufficient interaction opportunities to students so that students can have more chances to get to know each other, develop norms that they are used to in a face-to-face class (Slagter van Tryon & Bishop 2009), and eventually be willing to engage in learning related discourses with peers. Shackelford and Maxwell (2012) identified several student interaction activities that can best predict a sense of community, which are introduction, collaborative group projects, sharing personal experiences, entire class discussions, and resources exchanges.

In conclusion, students' interaction in online courses is a necessary component. It can promote learning and community building so that students sustain online learning. However, students' interaction is a high-maintenance task (Bull, Kimball, & Stansberrv, 1998); it is time consuming and can be challenging for some students.

Common Problems of Students' Interaction in Online Discussion Forums

Interaction has been recognized as an important factor for learning (Bernard et al., 2009); however, students' interaction does not always lead to the best possible learning outcomes due to low participation and low quality (Joubert & Wishart, 2012). Though students' interaction is important for learning and community building, the actual students' interaction in online courses is not as positive as expected.

Decreasing participation. Students' participation fluctuates during the course period and tends to decrease towards the end of the course. Several studies presented student participation patterns in the online discussion. Nandi et al.'s study (2011) described students' participation in online discussion forums of two online courses. The results showed that students' participation rate gradually decreases during the semester. Phirangee, Epp, and Hewitt (2016) compared students' participation in online discussions in the peer-moderating condition and the instructor moderating condition. The weekly numbers of notes written are steady at first but eventually decrease to near zero in the last few weeks of the semester. Similarly, in Rovai's (2001) study, the average number of posts in each thread showed a decreasing pattern, and the depth of each thread decreases, too.

Unequal participation. In addition to the variation in participation rate over time, a number of researchers also discussed the various activity levels among students. One of the criticisms of Computer-Mediated Communication is that a few people dominate the discussion and the majority does not contribute any messages (Romiszowski & Mason, 2004). Keeners refers to "peers who quickly and constantly respond to online notes, including discussions in which they are not a part" (Phirangee, Epp, & Hewitt, 2016, p.20). The "silent" majority is named Lurkers; most of the time their roles are as information recipients (Nandi et al., 2011; Romiszowski & Mason, 2004). However, students' participation in discussion forums is more complex than the two types of participants. Some students' participation falls in between the two extreme groups. By analyzing the messages posted in discussion forum, Yeh (2010) classified participation roles in more detail. She identified 13 online behaviors in both asynchronous and synchronous discussions in an 18-week training program. Then eight types of roles emerged, including Supervisors, Information providers, Group instructors, Atmosphere constructors, Opinion providers, Reminders, Trouble-makers, and Problem solvers. Among the active students, some of them took on more than one role in the discussion forums, while others took less. Some students took leadership roles automatically, and others preferred to share information or opinions.

Variation also exists in the messages-reading behaviors, which is called “listening” in Wise and her colleagues’ research (2012a, 2012b, 2013). Wise, Hsiao, Marbouti, Speer, and Perera (2012a) took a closer look at students who did not post frequently in online discussion forums. Through analyzing individual cases, Wise et al. (2012a) found that some students read all the messages but do not draw on them in his/her own posts. On the contrary, some students read few posts but build his/her own posts on them. Some students only read specific posts, and some students ignore all other posts. Wise, Marbouti, Hsiao, and Hausknecht (2012b) also found that students’ selection of message to read relied on the discussion reply-structure (such as having interaction previously, or having already received most replies) and time. Particularly, in blended courses, authorship is an important predictor for selecting messages to read. More importantly, Wise, Hausknecht and Zhao (2013) concluded that the quality of messages could be predicted by how many other posts the authors actually read.

Knowlton (2005) categorized students’ participation in asynchronous discussion forums into five levels, including passive, developmental, generative, dialogical, and metacognitive. Advocates for online discussion anticipate that all students are at higher participation levels because that is where learning happens. However, the above empirical studies showed that students' participation fall into various categories, and more are at lower levels. The various activity levels among students in online discussion results in an unbalanced interaction dynamic. Only a few students share and are heard. Moreover, students' habits of choosing specific messages to read and to reply increases the centralization of discourses. According to Scardamalia and Bereiter (1994), centralization is the least expected in a knowledge building process. In order to advance students' understanding, the interaction between students should be open, focusing on collective knowledge. In their view, even less knowledgeable participants played an important role, drawing attention to the most difficult concepts. If only a few people dominate the discussion forum, it does not help advance knowledge, but display a few individuals' achievement. Successful knowledge building discourse needs active and broad participation.

Interaction quality in online discussion forums. In addition to participation issues, the quality of the messages posted in the online discussion forums is another concern shared by researchers. Joubert and Wishart (2012) found that students' posts are usually composed of one or two sentences. The posts often do not build on each other's contribution; instead, students are used to posting messages from their own belief systems. Naranjo, Onrubia, and Segués (2012) used their own analytic framework to evaluate the cognitive quality of contributions in virtual forums in three dimensions (cognitive level, learning level, social-cognitive level). They found that even though most students access the discussion forum frequently, the cognitive quality of their contribution is generally low. Only one student consistently contributed high quality messages in two dimensions. Beckmann and Weber (2016) found repeated information and statements—frequent occurrences in the discussion forum. They believed this is due to the goal of students' participation as fulfilling task requirements rather than having curiosity and interests to the discussion topic.

In addition to the low content quality, the function of messages posted by students often serves knowledge building at a lower level. Sing and Khine (2006) examined a group of in-service teachers' interaction in a teacher training institute. They use Interaction Analysis Model (IAM, Gunawardena, Lowe, & Anderson, 1997) to analyze teachers' messages in the discussion forum, and they found that 60% of the messages were sharing information (Phase 1, IAM includes 5 phases to describe knowledge building discourses). Even though the density of teachers' interaction is considered to be high (teachers are well connected to each other), the expected knowledge building discourse was limited. Another study (Heo, Lim, & Kim, 2010) also found a similar issue: the depth of interaction is lacking even when a learning community exists. Schellens and Valcke (2005) randomly chose 8 groups' discussion threads from 23 groups in a freshman course; each discussion thread lasted for three weeks. By coding with IAM (Gunawardena et al., 1997), they found that about half of the students' posts were in Phase 1, where almost no higher level communication exists. They also compared the first discussion thread with the last discussion thread, and found the knowledge building discourse, in fact, decreases during the semester.

The studies mentioned above are not isolated cases. Lucas, Gunawardena, and Moreira (2014) reviewed studies used IAM (Gunawardena et al., 1997). In the 15 studies they selected, the majority of the messages in online discussions were in Phase 1 no matter how the activity was designed or which tool or platform was used in the study. Shearer, Gregg and Joo (2015) argued that it is all right for students to purely share information in the discussion forum, and they might still learn from each other's messages. It might be acceptable that the discussion forum shows only surface level learning, as long as students have other types of assignments to promote deep learning.

In conclusion, current issues of students' interaction in online discussion forums include students' various participation levels over time. Second, the various participation levels between students in online discussion forums exist. Some students are less active than others. This leads to highly centralized discussions, which is the least expected situation in a knowledge building class community (Scardamalia & Bereiter, 1994). Finally, low content and function quality of messages in terms of interaction are also concerns shared by researchers.

Possible reasons leading to the low participation and low quality. In order to find proper solutions to improve the problematic situation of students' interaction in online discussion forums, it was important to discuss the possible reasons leading to the issues.

Joubert and Wishart (2012) shared several reasons for low participation and low quality posts in their study. First, the social-culture setting shapes learners' behaviors. Students are used to finishing just the required work in school. Similarly, Peters and Hewitt's (2010) investigation of students' strategies used in online learning showed that students choose to use minimum effort to fulfill the course requirements. Even though some literature suggested that discussion should be graded (Rovai, 2007; Xia, Fielder, & Siragusa, 2013), Peters and Hewitt's research (2010) found it is the grading pressure that results in students' coping strategies in discussion forums. According to their study, students' overarching goal of the discussion activity is finishing the task rather than co-constructing knowledge.

Second, Joubert and Wishart (2012) argued that the nature of knowledge being built also plays a role in the problematic situation. The anchor questions of a discussion thread can influence the quality of discussion. When the question is belief-driven, it is hard for students to challenge each other. Therefore, some researchers tried to design the interaction activity in a way that is more meaningful for students to motivate them to participate (Hou, 2011; Zha & Ottendorfer, 2011).

Last, Joubert and Wishart (2012) argued that the software or the platform could also be the problem. The unfriendly interface can become a barrier to students' participation. Similarly, some researchers believed it is the learning environment that does not support students' interaction as expected (Gunawardena, Lowe & Anderson, 1997; Hewitt & Scardamalia, 1998; Scardamalia & Bereiter, 1994), so they developed new learning environments to offer more affordance for asynchronous discussion.

Currently, most solutions for improving students' interaction are focusing on the second and the third reasons argued by Joubert and Wishart (2012). Instructional design, including motivation design, is often used to improve the design of the discussion activity. New learning environments are developed to add theory-driven affordances for effective interaction. Examples are discussed in the following section.

Solutions Proposed in Previous Studies

Much endeavor has been made to improve students' interaction in online discussion at different levels and scales. There are two major schools of intervention: "software design and instruction design" (Bernard et al., 2009, p.1266).

Creating a new platform. Researchers (Gunawardena, Lowe & Anderson, 1997; Hewitt & Scardamalia, 1998; Scardamalia & Bereiter, 1994) argued that the platform for discussion shapes the process of students' interaction. Therefore, some of them developed new platforms with the functions and features they believed would benefit students' learning. Knowledge Forum is one of the famous platforms designed for a "many-to-many" (Hewitt & Scardamalia, 1998, p.84) learning environment. In Knowledge Forum, students create notes to contribute theories, models, plans, and references (Scardamalia, 2004) to the class. Different from the linear presentation of typical threaded discussions, the notes in Knowledge Forum can be displayed in various views and customized by the users. Furthermore, Knowledge Forum provides flexible ways for students to connect notes in order to build-on, link, and reference each other. By adding these features, Knowledge Forum intends to focus on the continual improvement of students' understanding, encourage collaboration and weaken the traditional teacher-centered class discourse (Scardamalia, 2004).

To improve the visibility of messages posted later in a threaded discussion forum, Marbouti and Wise's design (2016) transformed the traditional chronological view of discussion to a net-like view. Higher-level posts are in the center and the later posted messages are more towards the edge. Results showed that students' choice of which node to read is more purposeful and they read new posts in a more connected fashion.

Instead of changing the view of a thread discussion forum, other researchers tried to add annotation functions to discussion forums for improvement. Eryilmaz, Ryan, van der Pol, and Kasemvilas (2013) developed a discussion platform for students where the article or artifact discussed is also displayed in the discussion forum window. This platform is a combination of annotation system and a discussion forum. This true experiment design study showed that students' postings are more theory-based rather than experience-based in the platform. In another study, Eryilmaz, Chiu, Thoms, Mary, and Kim (2014) added a new function to the platform, where users can highlight important sentences in the article discussed. The results showed that both instructor-based and peer-oriented attention guidance make students focus on difficult concepts and examples.

Facilitating discussion often comes with a large amount of work. Researchers developed visual tools to provide teachers visualized information about students' participation. Calvani, Fini, Molino, and Ranieri (2010) developed a tool to visualize students' interaction in order to help tutors obtain a better image of the interaction in the discussion forum. Therefore, the tutors could be more efficient to facilitate discussion.

The above cases tried to improve the discussion experience for students. However, if the participation rate is still low, these new platforms cannot benefit student learning. Practically speaking, it is not realistic for any instructional designers and teachers to develop a new platform or customize new features. Therefore, some researchers choose to design the discussion activity in a more meaningful way to engage students in the knowledge building process.

Instructional design and motivation design. Rovai (2007) synthesized a series of strategies of design and facilitating online discussion. He believed it is important to design the discussion in a way that can generate students' motivation. He listed several principles, such as grading the discussion, creating authentic tasks, allowing students to choose the discussion topic, and contextualizing the discussion to make the topic related to students' backgrounds. Rovai (2007) believed it is also important to create clear rules for students and help them set the right expectation, and the final goal for discussion should be nurturing a community. Similarly, Xia et al. (2013) summarized several strategies for designing and facilitating online discussion, including rewarding points for participating in discussion, sharing responsibilities of facilitating the discussion, creating a social friendly environment, setting expectations, and adding training of self-discipline and time management for students.

Among all the design strategies, role-play is a frequently mentioned term in online discussion intervention studies. There are two types of role-play design. The first type of role-play is often accompanied with problem-based learning. Students play roles as characters in a problem scenario, and they converse about solutions in the discussion forum. Hou (2011) compared the effectiveness of discussion designs that used authentic problems only and that combined problem-solving with role-play. He found that in the role-play condition, students' opinions posted are more diverse. Another study of role-play (Hou, 2012) showed that students are more motivated, and their argumentation skills are more developed.

Another role-play design of discussion activities is often referred to as role-assignment. The roles students play as are based on the responsibilities of participating in a discussion, e.g., facilitator, starter, responder, synthesizer. In Xia and their colleagues' (2013) study, students play the roles as starters, responders, and facilitators. They found that a student's final grade is related to the roles they have played. As starters only ask questions without responding to other students, they have lower scores compared to other students. In some studies, not all students are assigned to roles; in Zha and Ottendorfer's study (2011), they only assigned some students a leader's role. Other students automatically become responders. The results showed leaders perform better in lower-order thinking skills. Xie, Yu, and Bradshaw (2014) conducted a similar intervention, where they assigned only moderator roles to students. The study found that students perform better when they are moderators in terms of quantity, diversity, and interaction attractiveness. Both Zha and Ottendorfer's (2011) and Xie et al.'s (2014) studies showed leaders/moderators outperform other students, while Seo (2007) found that all students perform better as long as there is a peer moderator. Instead of assigning roles to students, in Seo's study (2007), students volunteer to be the moderators for the whole semester and do not take turns.

Brewer and Klein (2004) added a rewards structure in addition to their role-play design. The roles in this study are facilitators, answer drafters, and verifiers. Researchers found that when students are assigned roles, and at the same time the whole group could get rewards if all members perform well, students post the highest number of messages in the forum. However, in the rewards-only condition, students post mostly off-task messages.

Some researchers argued that peer moderation design achieves a better result when facilitators receive training (Gilbert & Dabbagh, 2005). Zydney and Seo (2012) proposed an alternative strategy; they adopted a protocol of interaction in an online discussion forum. The protocol defined who responded, when to respond and how to respond. The comparison with no protocol design showed that the protocol design “more evenly distributed the presence of cognitive, social, and teaching elements necessary to create and sustain an online community of inquiry” (p.77).

In summary, previous studies demonstrated their effectiveness on improving students’ interaction in online discussion forums. However, neither developing a new learning environment or redesigning the discussion activity address the problem of how the social-culture setting of school shapes students’ behavior to getting good grades instead of learning. Gamification as a motivation design is now a popular choice used to improve students’ engagement in both online and face-to-face courses. Though there are researchers who chose to create new platforms for gamified courses (Ding, Er & Orey, 2018; Ding, Kim & Orey, 2017), many gamification studies simply took the advantages of the learning management system to carry out the gamification design in online courses. In the next section, I introduce the discussion of gamification’s definition and its application in educational fields.

Gamification

What is Gamification?

One of the most widely cited definitions of gamification is from Deterding and coauthors' 2011 paper. They defined gamification as "the use of game design elements in non-game contexts" (Deterding et al., 2011, p.2). To specify the scope of their definition of gamification, they discussed the definitions of game, game elements, game design, and non-game contexts. First, they differentiate gaming from playing. Gaming is rule-based, goal-oriented and competitive, while playing is open and free-form exploring. Meaningful gamification (Nicholson, 2015) defines gamification in a broader way compared to Deterding et al.'s (2011) in terms of the definition of game. Meaningful gamification integrates "playing" into gamification to address the potential motivation issues caused by pure extrinsic rewarding. For example, points and badges in Nicholson's (2015) point of view are extrinsic motivators, which may hurt students' learning eventually. Therefore, he stressed meaningful gamification as an alternative strategy to motivate users for certain purposes via Play, Exposition, Choice, Information, Engagement, and Reflection.

Second, Deterding et al. (2011) defined game elements in a flexible way: game "elements that are found in most (but not necessarily all) games, readily associated with games, and found to play a significant role in gameplay" (p. 4). Due to the various genres of games, it is not possible to give a complete list of all game elements. Bedwell and coauthors (2012) provided a list of game elements that are necessary for education and training purposes in order to develop serious games. They searched game attributes in literature that can engender learning. They finalized nine attributes: Action Language, Assessment, Conflict/Challenge, Control, Environment, Game Fiction, Human Interaction, Immersion, Rules/Goals. Based on this list, Landers (2015) proposed that the definition of gamification in education should be using the above-mentioned nine elements individually or in meaningful combinations to facilitate learning and related outcomes.

Third, Deterding et al. (2011) made a distinction between the use of game design and the use of "game-based technologies or practices of the wider game ecology" (p4), such as graphic visualization, game controllers, etc.. Repurposed use of these game elements is excluded from their definition of gamification.

Finally, Deterding et al. (2011) referred to the non-game context as the context where users do not expect for an entertainment gaming experience. Gamification is commonly used in marketing, health care, libraries, and education "to advance goals outside the context of a game" (Brigham, 2015, p. 473).

Gamification design in non-educational fields. Gamification is first mentioned in 2002 (Tulloch, 2014); however, until 2010, the use of this term wasn't widespread. Among all the areas that have employed gamification, marketing is a successful example.

From a service marketing perspective, Huotari and Hamari (2012) defined gamification as "a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation" (p. 19). In their opinions, the similarity between games and service marketing is that both the experience of service and gaming are co-produced by providers and consumers. They viewed gamification as one attempt to enhance a service. The use of gamification does not guarantee the success of sales. Therefore, the standard of successfulness for gamification should be focusing on the gameful experience instead of marketing figures. To do so, they distinguished the core services that a business provides from the enhanced service that gamification adds. For example, a core service of a café shop is selling coffee, and the enhancing service can be “mayorship competition in Foursquare” (p. 20); the gamification service here is the competition of loyalty between customers in order to increase retention.

Robson, Plangger, Kietzmann, McCarthy, and Pitt (2015) proposed three gamification principles in business on how to create a gamification experience. The three major components in gamification are Mechanics, Dynamics, and Emotions (MDE). They (Robson et al., 2015) suggested the gamification designers should first select gamification mechanics, including setup mechanics, rule mechanics, and progression mechanics. Following the mechanics, designers should predict the user dynamics that may emerge during the process and emotions that can be evoked among the users. Moreover, the three components are not separated from each other; user dynamics and emotions can shape the mechanics and vice versa. Therefore, the key for a successful gamification design in their opinion (Robson et al., 2015) is to understand the relationship between the three components in the targeted context.

In his book *Actionable Gamification Beyond Points, Badges, and Leaderboard*, Chou (2015) proposed a design framework with eight Core Drives: epic meaning & calling; development & accomplishment; empowerment of creativity & feedback; ownership & possession; social influence & relatedness; scarcity & impatience; unpredictability & curiosity; loss & avoidance. Beyond the eight Core Drives, Chou (2015) suggested gamification designers consider the four phases that users would experience: discovery, onboarding, scaffolding, and endgame. Chou (2015) emphasized that the presence of any of the eight drives should be in all four phases, or users may leave the system.

Gamification in Education

The purpose of using gamification in education is similar to marketing. In their review of gamification research in education, Caponetto, Earp, and Ott (2014) found that a common goal of applying gamification in education is to “improve/increase” the target audience’s “motivation/engagement.” Similarly, Brigham (2015) summarized that gamification in education is to “enhance learning, motivate students in the learning process, and or increase engagement in an academic course” (p. 473). However, Landers (2015) questioned whether gamification can influence learning directly. He stated that it may not be valid to say that students can learn from gamification. He saw gamification as a toolkit; by using it, the intention was to improve pre-existing instruction so that students’ learning behaviors or attitudes can change. In his paper, Landers (2015) proposed that gamification can bring changes in behavior and/or attitudes which could then influence learning eventually. His point of view about the relationship between gamification and learning is similar to Huotari and Hamari’s (2012) view of gamification and core service—that gamification is an add-on to the core service. In educational context, core service is instruction, and gamification is the enhancing service in order to attract learners. Gamification is one of many approaches to make pre-existing instruction more appealing.

In addition to Landers (2015), Huang and Soman (2013) pointed out that in order to help students achieve learning goals, it is the learning process that the educators should gamify. In the *Practitioner’s Guide to Gamification of Education*, they proposed a five-stage design process: “Understanding the target audience and the context; defining learning objectives; structuring the experience; identifying resources; applying gamification elements” (p. 7). They emphasized that it is important to define learning objectives clearly so that the “pain point”, factors that prevent students from advancing in the learning process, can be identified. Then the teacher could choose appropriate game elements to influence students’ behaviors to overcome the “pain point” and achieve those objectives.

In their analysis of gamification in education, Scott and Neustaedter (2013) proposed four game elements that can bring more successful design in learning environments, which are freedom to fail, rapid feedback, progression, and storytelling. Similar elements were also mentioned in Xu and Ke's (2016) discussion of designing a game-like math learning environment. They believed that the cycle of challenges (trial and error) with the instant feedback and perception of progress are the key elements for engagement. Ramirez and Squire (2014) summarized several design heuristics through the lens of school's achievement system, such as, recording learning progress; providing feedback on progress; promoting transparency in assessment; encouraging mastery; reframing the game experience to promote reflection; making knowledge more flexible (trying contrasting cases); encouraging collaboration; and modeling for users what experts are and can do.

Gamification study examples in education. Besides the conceptual discussion of gamification and gamification design, empirical studies on gamification in the educational field have emerged in recent years. Below are several successful examples. Bellotti et al. (2013) gamified a one-month entrepreneurship course for electronics engineering students. Students were divided into teams. They could collect points for participating in the course activities. A leaderboard was used to present the rank for each team. The results showed that their gamification design maintained students' interests in the course. The researchers believed that the quality of course content and gamification tools were both key factors for the success.

Çakıroğlu and colleagues (2017) added gamification elements to a face-to-face ICT course for preservice teachers. Their gamification design showed a positive influence on student engagement. The gamification design was centered on the leaderboard, which ranked students based on their performance of the tasks in alignment with the learning objectives. Moreover, the top students in the leaderboard received real gifts and were given a chance to perform the role of the teacher. Points were rewarded to students who answered the questions correctly in the class. One feature of this gamification design is that it gives students ample opportunities to present their competencies regarding the learning topics.

Tsay, Kofinas, and Luo (2018) also received positive results when implementing gamification design, which included a leaderboard and four different types of badges in a college level Personal and Professional Development course for 136 undergraduate students over two academic terms. In their gamification design, they differentiated two kinds of learning activities: “Essential Learning” and “Super Learning.” The former one focused on the content in the course, and was delivered through short texts, quizzes, and videos, which were embedded with game features as “Freedom to fail” and “Rapid feedback.” Super learning aimed for advanced learning content. Students had the “Freedom to choose” what, when and where to participate in these online activities. In this gamification design, Tsay et al. (2018) provided students an adequate number of choices to decide how to learn and present their competence

Ding and her colleagues (2017, 2018, 2019) created a gamified online discussion tool and implemented it in multiple settings with positive results in terms of cognitive, behavioral and emotional engagement. Their online discussion tools included basic discussion board features with badges, points, leaderboard, progress bar, and rewards. The badges laid out the specific learning behaviors that were expected in the online discussion forum. Earning badges could also win students experience points, which could bring them non-physical rewards. In Ding and her colleagues’ design, they offered students clear behavioral objectives and a sense of competence through different badges.

Critiques of gamification in education. Though gamification studies displayed successful results in various fields, there are some critiques of gamification from game designers and researchers. Most of their argument is about what the core game mechanism indeed is. They believe the widely recognized game mechanism in the gamification field cannot represent what a game truly is—especially points, badges, and leaderboard (PBL, a popular gamification design). The PBL approach is simply a superficial imitation of games (Chorney, 2012; Bogost, 2011). However, these critiques, in fact, were due to the lack of a consistent definition of games and game elements for both game and gamification designers and researchers (Tulloch, 2014).

At the same time, gamification in education is facing its own challenges. With the broad definition, gamification designs in practice are diverse. Even among gamification cases using points, badges, and leaderboard (PBL), the specific design of these elements can vary. Therefore, it is hard to make a conclusion that gamification design works or not. The various gamification designs also reflect the absence of a universal design framework to support and guide the design and development of gamification. Self-Determination Theory (SDT) and the concept of extrinsic and intrinsic motivation are a frequent choice in gamification studies. However, Seaborn and Fels (2015) found that even within the research that used the SDT framework, they differed in three ways: whether the specific sub-theories are mentioned, to what degree the specific game elements are related to the specific theory or sub-theory, and what constitute the interpretation values. A disconnect exists between theoretical grounding and application cases in gamification research. Moreover, empirical studies are needed to validate the theoretical framework for design. This disconnect may lead to unwanted research outcomes. Dicheva and Dichev's (2015b) review discloses such drawbacks that the gamification community is facing. Compared to their earlier review on gamification studies (Dicheva, Dichev, Agre, & Angelova, 2015a), a significant portion of more recent studies showed inconclusive results of gamification's influence on students' engagement. More importantly, the endurance of motivation evoked by gamification is also in question. A recent review with a specific focus on gamification in online programs showed that 12 out of 15 experimental studies found positive influences of gamification in terms of direct engagement and downstream outcomes (Looyestyn et al., 2017). However, the review also found that gamification interventions in a single setting presented a clear, positive impact, but the interventions over time showed a more mixed result. These results reveal that gamification design might temporarily improve students' motivation, but once it is not a novelty to students, reduction in participation shows up.

In addition to the lack of a well-validated design framework and the inconsistent study results, another fundamental issue of gamification research in the educational context is the ambiguous role of instructional activities, which researchers often neglect to report in gamification studies. As summarized above, gamification design in education is often used to improve motivation (Caponetto et al., 2014). However, as Keller (2009) stated, instruction should be both appealing to students and effective for learning. In other words, the increased student engagement in poorly designed instructional activities cannot be a guarantee for effective learning. Landers (2015), in his theory of gamified learning, proposed that different from serious games, which are designed to affect learning directly, gamification "affects behaviors/attitudes that moderate instructional effectiveness" (p. 10), or affects behaviors/attitudes that result in the learning outcomes (a mediating process). In both processes that Landers (2015) proposed, the quality of instruction is the key to the learning. Therefore, it is critical to ensure that the instructional activities the gamification design promotes students to participate in lead to learning.

Lee and Hammer (2011) described two possibilities when combining gamification and education together. By appropriate use of the gamification design in school, it can provide students a non-common experience, motivating them to learn and become a learner, which is when “chocolate met peanut butter” (p. 4). However, a poorly designed gamification experience will turn into “a chocolate covered broccoli”: a simply rule-based experience (p. 4). In contrast with Landers’ mediating and moderating process of gamification on learning, Lee and Hammer (2011) thought gamification would bring positive influences on learning when the instruction and the gamification are complementary to each other.

In my opinion, using game elements in the educational field should not be simplified as adding a novelty game layer, but to carefully select, combine, and integrate game elements with the appropriate instructional activities and the context of the subject topic. In the next section, I discussed the theoretical foundation of gamification design for this study: Self-Determination Theory explained the attractiveness of a game, how it informed gamification design in education, and how situated learning theory informed designers to contextualize the gamification design in a specific course.

Theoretical foundations of Gamification Design in the Study

Games as a popular entertainment is well accepted by most people. A study conducted by the Pew Internet and American Life Project finds that 49% of American adults play games on their devices, 10% of them consider themselves to be gamers (Duggan, 2015). More than half of the participants believe that video games “help develop good problem solving and strategic thinking skills” (p.11). According to Entertainment Software Association’s (ESA) report (2017), the average game player is 35 years old. Among people who identify themselves as game players, 45% are older than 36. This indicates gaming is not only among adolescents. Adults still have a gaming habit and take it as a main approach to entertainment (ESA, 2017). Efforts for using games in education have also been popular (Squire, 2006). However, in order to make effective use of game, or game elements, it is important to know why game is attractive to people and how such game could be designed. In this way, educational researchers can build their own gamification design on a solid theoretical foundation, applying “the principles that make games fun in the design of other activities” (Ryan & Deci, 2017, p. 530). In this section, I discussed the potential motivation mechanisms from two theoretical perspectives: Self-Determination Theory and Situated Learning Theory.

Self-Determination Theory (SDT)

Self-Determination Theory is one of the important motivation theories and was first proposed by Ryan and Deci (Gagné & Deci, 2014). This theory focuses on social-contextual factors that facilitate or hinder people’s development through the satisfaction of a human’s three basic psychological needs: Competence, Autonomy, and Relatedness. SDT pictures motivation as a continuum from control to autonomy. Intrinsic motivation is by definition autonomous. Intrinsically motivated behaviors are not driven by any “reward,” but pure feelings of effectance and enjoyment along with the behavior. In contrast, extrinsic motivation can vary in degree of control and autonomy. But Ryan and Deci (2017) also argue that extrinsic motivation can become more autonomous when a person accepts the value of the extrinsic behavior, “These more autonomous forms of regulation are experienced as more volitional, and quality of persistence and performance is higher than with controlled motives for acting” (p. 15). Ryan and Deci propose that the outcome results from the feeling of self-determination (autonomy), the feeling of effectance (competency), and the feeling of belonging (relatedness) that support the intrinsic motivational process (Ryan & Deci, 2017). In addition to the basic concepts, SDT developed six mini theories to explain how the social factors influence the satisfaction of the three basic psychological needs and influence human motivation and well-being. The six mini theories are: Cognitive Evaluation Theory, Organismic Integration Theory, Causality Orientations Theory, Basic Psychological Needs Theory, Goal Contents Theory, and Relationships Motivation Theory.

The three basic psychological needs. Plant needs air, water, and sunlight to grow. Humans need certain resources or nutrients to thrive; the deprivation of these resources or nutrients can put life in danger. Likewise, the satisfaction of the psychological needs is critical to a human's well-being. In Maslow's hierarchy of needs, needs are divided into basic needs (such as physiological needs) and growth needs (such as esteem needs). Once the basic needs have been satisfied, man may start to pursue the growth needs (Koltko-Rivera, 2006). Murray defined needs as forces that can transform an existing unsatisfying situation, which, according to Ryan and Deci (2017), fails to distinguish actual basic needs from desires, preferences, and appetites. Conversely, Ryan and Deci defined the basic psychological needs as essential for human development and thriving, thus, the needs frustration or neglect would results in ill-being. Furthermore, the basic needs should be universal, which means it is critical across cultural contexts and each stage of human development. Based on these criteria, Ryan and Deci proposed autonomy, competence, and relatedness as the three basic psychological needs.

Autonomy. Autonomy refers to "the need of individuals to experience self-endorsement and ownership of their actions – to be self-regulating in the technical sense of that term" (Ryan & Deci, 2017, p. 86). Actions that do not involve other people's domination are autonomous actions. At the same time, if the action is autonomous, people will engage in the action with "the whole of their resources, interests, and capacities" (p. 97).

Numerous studies showed that the autonomy support is a strong predictor of student engagement (Ryan & Deci, 2017). For example, Sheldon and Krieger (2007) conducted a three-year longitudinal study in two law schools, and found the problematic institutional culture resulted in a decline of students' well-being and motivation. While for students who perceived greater autonomy support from faculty, their decline of needs satisfaction were less, and they had higher grade points. Students in the more controlling institution suffered more difficulties. A study (Williams, Saizow, Ross, & Deci, 1997) of medical students' career choice showed that the areas that students selected for their residency were related to their perception of the autonomy support during their medical rotations, and was mediated by their perceived competence and interests. Other studies (Black & Deci, 2000; Williams & Deci, 1996) provided evidence that students who perceived autonomy-supportive from the instructors more fully internalized the value of the course work and the subject area content, and they performed better in the course and in practice.

Ryan and Deci (2017) gave some example autonomy-supportive teacher behaviors, including: listening to students; making time for students' independent work; giving students an opportunity to talk; acknowledging signs of improvement and mastery; encouraging students' effort; offering progress-enabling hints when students seem stuck; being responsive to students' comments and questions; acknowledging students' experience and perspectives (p. 368).

Competence. Competence refers to "feeling effective in one's interactions with the social environment – that is, experiencing opportunities and supports for the exercise, expansion, and expression of one's capacities and talents" (Ryan & Deci, 2017, p. 86). The concept of competence in SDT is developed based on White's work, in which the concept of competence was detached from rewards or benefits that can be attained from competent behaviors, conversely, competence is defined as “an intrinsic need to experience feelings of efficacy” (p. 95). White argued that this need results in skill acquisition, and the need for competence helps people maintain their engagement in the learning process (Ryan & Deci, 2017). Such pursuit of success will not be fulfilled if the task or the challenge does not require people to exercise any capacities or skills. In other words, succeeding at an easy task does not help people to feel mastery. As competence is an intrinsic need for growth, tasks that have no room for development are unlikely to make people feel growth, and are, therefore, unlikely to satisfy people’s need for competence. Ryan and Deci (2017) suggested that the most compelling feeling of effectance comes from exercising and enhancing skills or abilities. When people engage in such tasks and challenges, positive feedback can typically enhance people’s intrinsic motivation.

In the school context, learning activities that allow students to expand their academic capabilities can support students’ competence needs (Niemiec & Ryan, 2009). However, grades which always come with learning activities as feedback do not always bring positive experiences for students. Even though grades should function as competence-relevant feedback and are supposed to have strong informational significance, some empirical studies proved they discourage students from putting more efforts into learning. For example, Benware and Deci (1984) conducted a study of 40 college students. Students in the experiment group were told to learn the materials in order to teach other students; students in the control group were told to learn the same material in order to take an exam. Though students in both groups presented similar rote learning scores, the experiment group students had higher conceptual learning scores and higher intrinsic motivation.

The competence needs and autonomy needs are interrelated to each other (Ryan & Deci, 2017). For example, when accomplishing a task (competence) that the person is willing to take on at the beginning (autonomy), the satisfaction can be enhanced.

Relatedness. Relatedness refers to "both experiencing others as responsive and sensitive and being able to be responsive and sensitive to them- that is, feeling connected and involved with others and having a sense of belonging" (Ryan & Deci, 2017, p. 86). Unlike competence and autonomy, feeling relatedness involves other persons. People can make efforts in the way that they believe will achieve relatedness; the feeling of relatedness will occur only when the person feels acknowledged and affirmed for the efforts.

Studies of students' sense of relatedness include their relationship with teachers, parents, and peers, and how the relationships influence the academic outcomes. Furrer and Skinner (2003) summarized that peers are critical to children's school participation and completion. Children who felt loneliness and social isolation were more dissatisfied from academic activities and eventually quit school. In their study of 641 children from 3rd to 6th grade, they found that the relatedness toward peers could predict the behavioral engagement and emotional engagement. The sense of belonging also plays an important role for college students. A study of 212 undergraduate students (Zumbrunn, McKim, Buhs, & Hawley, 2014) provided evidence that the perception of belonging to a single class predicted students' engagement and achievement in the course. In the work of Zumbrunn et al. (2014), belonging was measured by items like: "I feel like a real part of this class;" "Students in this class treat me with respect;" "I can talk to students if I have a problem" (p. 667). The following interviews of students further explained that the sense of belonging to a class came from the interaction with peers. Students with higher belonging scores expressed that they voiced their opinions on certain topics and people felt comfortable to do so. While students with lower belonging scores had a completely opposite experience—they did not feel comfortable enough to share their opinions. Academic differences could also set apart students. Some students struggled with unengaged peers in small group activities.

A key element of relatedness is the feeling that one matters to others. People want to be heard; knowing they are being heard can help fulfill the needs of relatedness. The Relationships Motivation Theory (RMT), one of six mini-theories of SDT (Ryan & Deci, 2017), points out that the need for relatedness is intrinsic. Not all social interaction affords a sense of relatedness. Only the experience involving "acceptance and support of the self" makes people feel relatedness (Ryan & Deci, 2017, p. 296). Rigby and Ryan (2011) identified three elements that can elevate satisfaction, which are acknowledgement, support, and impact. The first is for people to know that they have gained others' attention. Furthermore, beyond being understood, people need others' support for being who they are and doing what they want. Finally, people need to see their own impacts on others. For example, it can be the laugh after telling a joke, or saving people from a natural disaster. Therefore, Ryan and Deci (2017) argued that giving support can also fulfill relatedness needs of the giver, as such behavior has an impact on the receiver.

Cognitive Evaluation Theory. Cognitive Evaluation Theory is the earliest developed mini-theory under the SDT framework, and it primarily explains how social conditions impact intrinsic motivation (Ryan & Deci, 2017). Ryan and Deci summarized that events that support the perception of competence and autonomy can enhance intrinsic motivation, and both autonomy and competence satisfaction are required for maintaining intrinsic motivation. Moreover, for activities that include social elements, a sense of belonging and connectedness can enhance intrinsic motivation.

Ryan and Deci pointed out that tangible rewards undercut intrinsic motivation because they thwart autonomy. They further summarize that controlling rewards, threats of punishment, evaluations, surveillance, deadlines, and imposed goals can undercut the feeling of autonomy, as these behaviors are "salient and powerful external stimulus" (p. 150). Such events either "promote a more external perceived locus of causality or have a significance of control" (p. 129), and, thus, undermine autonomy and decrease intrinsic motivation. On the contrary, if people have the power to choose what they want to do, they will feel a greater sense of autonomy and it may also increase intrinsic motivation. They also pointed out that the choices available to people should be meaningful, and the options should have real values to the person.

Optimal challenges and informational feedback are some events that can provide people feelings of competence, and, thus, enhance their intrinsic motivation. Ryan and Deci summarized that events that influence people's perceived competence affect their intrinsic motivation. Specifically, events that satisfied a person's competence need by promoting greater competence can improve his/her intrinsic motivation.

However, it should be noted to what degree an event alters a person's perception of autonomy and competence depends on the meaning that the person gives to it. An event can be experienced as controlling, informational, or amotivating. When an event signifies a controlling function to a person, it promotes an external perceived locus of causality, which diminishes intrinsic motivation. When the informational aspect of an event exceed the other two aspects, the person perceives an internal locus of causality; therefore, it supports intrinsic motivation. Finally, the amotivating aspect indicates lacking the capacity to achieve the outcome or having no value in it, which results in the decrease of both intrinsic and extrinsic motivation. Ryan and Deci suggested that tangible rewards are more likely to signify a controlling function to people, while unexpected rewards or positive feedback are more likely to signify an informational function.

Ryan and Deci have also pointed out that what is being rewarded can help predict its functional significance, they categorize rewards into different types: rewards for being present, rewards for being engaged, rewards for completing, rewards for reaching a specific performance standard, and rewards for winning in a competition. Particularly, for the rewards that need a person to engage in a task, they signify the controlling function. While completion discloses some amount of competence affirmation, it could cancel out the controlling aspect to some degree, compared to pure engaging. However, a meta-analysis (Deci, Koestner, & Ryan, 1999, as sited in Ryan & Deci, 2017, p. 136) showed the rewards for engaging and completing significantly diminished intrinsic motivation, while the two types of rewards were less detrimental for college students than for children.

Rewards for performance also signify a controlling function, as the person feels forced to reach a standard to receive the reward. Meanwhile, rewards for performance also transmit competence information. However, the meta-analysis result showed this type of rewards also had a negative impact on intrinsic motivation. Ryan and Deci (2017) indicated that the rewards for performance and competition should be used carefully since there are participants who are motivated to do the task but do not get the rewards. This group of participants is likely to experience both low autonomy and competence.

It seems most external events are inclined to diminish intrinsic motivation; however, it should be noted that most of this research was conducted in a laboratory environment. Participants may not necessarily have any intrinsic motivation in the task assigned to them, such as solving puzzles. In a school context, especially higher education, students' choosing to take a course is probably because they are intrinsically interested in the topic or the course had instrumental value to them. The following section discussed the events that can make a person feel autonomous and competent in a real world context: game and gamification.

The Playing Experience of Need Satisfaction (PENS) model. Self-Determination Theory describes how social conditions can intrinsically motivate people. To further study how digital video games attract numerous gamers and maintain their engagement, Ryan and colleagues conducted a series of studies to answer the question (Ryan et al., 2006). Applying a measure of needs satisfaction, PENS, they studied what game characteristics were in relation to participants' future play. Three studies were conducted in laboratory environments by using single-player games. The results showed that the satisfaction of autonomy and competence increased preference of future play. A fourth study administrated the survey questionnaire in an online game community with a focus on Massively Multiplayer Online games; likewise, the satisfaction of autonomy, competence, and relatedness showed independence contributed to explaining the intended future play.

In the 2007 report and the 2011 book, *Glued to Games*, Rigby and Ryan further summarized that PENS as an instrument can be used to predict a game's success in terms of "fun/enjoyment," "game ratings, sales, developer loyalty, and sustained player interest." (Rigby & Ryan, 2007, p2). They also suggested PENS could be used as a design framework for game developers. Table 1 provided a summary of the definitions and examples of the three basic needs in a game context.

Competence. Competence satisfaction is fulfilled in games in different ways. One major approach is through a rich positive feedback system. The feedback system in games is usually presented in three aspects: granular, sustained and cumulative (Rigby & Ryan, 2011). Granular feedback is immediate feedback of players' action; it can be the visual and/or auditory cues, blood loss of a character, the enemy's reaction when hit and so on. Granular feedback provides competence satisfaction immediately and constantly. Sustained feedback occurred when the players have a flawless performance in the game; it could be score multipliers or a power-up. This type of feedback provides information for players to gauge their performance or set new goals. Cumulative feedback recognizes the players' growth and documents their progressed abilities. Such feedback can be offered to the players by the changes in the game environment, new weapons or collections, records, or scores and points. The three types of feedback in digital games compose "mastery feedback loops" (p. 23) that provide players competence satisfaction.

Players received these types of feedback through taking actions to conquer challenges in the games. However, how difficult should the tasks and challenges be? Research showed that when the challenge matches a player's levels of abilities the closest, the players experience a strong sense of ability. The granular and sustained feedback delivered the information of the player's mastery. Meanwhile, the increasing of the difficulty of the challenges with the cumulative feedback tells the players the development of their skills in the game. This continual growth pattern encourages the players to come back to the game and seek these opportunities to experience mastery. Additionally, Rigby and Ryan (2007) also stressed that focusing only on the optimal challenges idea leads the game developers to fail to give players opportunities to express their mastery. Some easier tasks that allowed the players to present mastery, though, did not extend the player's ability, but satisfied the player's competence needs. This seems to be contradictory to the cases in other contexts where a person's satisfaction of competence may not be satisfied by performing a task that did not stretch their abilities (Ryan & Deci, 2017). Most people play games for leisure purpose, these satisfactions of competence can effectively boost people's mood (Russoniello, O'Brien, & Parks, 2009)—especially if they are not able to get competence affirmation from other activities.

Autonomy. Autonomy in games refers to the experience of volition or choices in players' decisions and actions. To fulfill the autonomy need, a game provides choices through the decisions of identity, activity and strategy, and open-world design. These choices should also be meaningful and volitional in order to satisfy players' autonomy needs. Meaningful choices include being able to make decisions of who to be and what to do, while volitional engagement requires the players understand and respect the value of the actions that they take even if there is no choice present.

Rigby and Ryan (2007) suggested game designers maximize the player's opportunities for action, which is defined as "the options that the player perceives as available to them at any given time during gameplay" (p. 11). Digital games provide players a wide choice of identity building so that the players can make choices without any borders. These choices might not be accessible due to cost or other constraints in real life. For example, in Role Playing Games, players have many opportunities to customize their characters—not limited to the looks and abilities, but personalities, and even ethical qualities.

Moreover, digital games include a number of interactive objects and the choices for a player to interact with those objects, such as collect, defeat, and combine to achieve the goals. For example, in Role Playing Games, they always combine players' choices with the narratives meaningfully, so players make their own storylines among multiple possibilities. At the same time, each choice that the player makes reflects his/her customization of the character in game.

Finally, successful game design does not take players' interests for granted. It provides strong rationales to persuade the players to move forward along the path in the game. For example, in Turn-Based Strategy Games, players may not embody any avatar on screen; however, the players are in full control of the strategies to achieve the victory goals in different ways. In the process of making these decisions, the players were empowered. Conversely, in simulations, there is no particular storyline to follow or victory goals to pursue; the players create their own stories in the simulation.

Relatedness. Relatedness in games is “the intrinsic desire to connect with others in a way that feels authentic and supportive” (Rigby & Ryan, 2007, p. 13). Acknowledgement, support, and impact are the three critical elements for relatedness satisfaction, as previously described. In multiplayer games, players experience relatedness through teaming up and belonging to a guild; they collaborate to conquer the challenges, and communicate with each other through in-game chat or other instant messenger tools. The cooperative play allows the team to conquer a challenge that was not achievable by a single player. Each player matters to the team and is supported by one another. Moreover, they experienced the satisfaction of competence together. Even in competitive play, the opponent of the players gave them opportunities to increase their competence. While not all competitions have good impact, destructive competition can thwart relatedness needs satisfaction when players feel that the opponents try to destroy them. Therefore, Rigby and Ryan (2011) suggested the game developers should design game mechanics that discourage destructive competition.

Additionally, single-player games can also create relatedness moments for players, such as using Non Player Characters (NPC) to support the player’s autonomy and competence through providing players positive contextual feedback where the conversation with the NPC is not scripted but depends on the player’s actions. In addition, when the NPC provides aid to the players, it elicits emotional responses from the players toward the NPC. Finally, the NPC can also be used to acknowledge the impact that the players make on the game world. Rigby and Ryan (2007) further explained that video games usually put players in a hero position, so that the player can experience the responsibilities of the hero character, and help the people who depend on the hero character; what they need to do deeply influences the fictional world they are in.

Beyond the satisfaction of relatedness from the game world, web forums and other Internet-based communication channels also help build bond among players. Ferguson and Olson's (2013) study showed that game play is a social activity among children. Children play games to make new friends or just play with friends.

Table 1 *Definitions of the Three Basic Psychological Needs in Game Context and Examples (Rigby & Ryan, 2011; Ryan &Rigby, 2007; Aparicio, Vela, Sánchez, and Montes, 2012)*

Needs	Definition in Game Context	Examples of Game Design
Competence	"the intrinsic need to feel a sense of mastery or effectance in what one is doing" (Ryan &Rigby, 2007, p.5)	Optimal challenges A rich positive feedback system Progressive information Intuitive controls
Autonomy	The experience of volition or choice in players' decisions and actions.	Opportunities for action Choices Profiles, avatars Macros, configurable interface Alternative activities Privacy control, notification control
Relatedness	"the intrinsic desire to connect with others in a way that feels authentic and supportive" (Ryan &Rigby, 2007, p.13)	Teaming up Positive contextual feedback Connection to social networks, chat, blogs

Reviewing competence needs satisfaction based gamification design. Since gamification by definition is using game design elements in non-game contexts, whether the game characteristic identified in the PENS model can work as well in a non-game context is a question worth exploring. Points, badges, and leaderboard (PBL) are the three common elements used in gamification design. These elements reflected the outcomes that resulted from participants' actions in a gamification setting; as a result, they could be counted as a feedback system that could satisfy participants' competence needs (Sailer, Hense, Mayr, & Mandl, 2017). In this section, several empirical gamification studies were reviewed in order to examine how the three elements work in gamification designs from a PENS model perspective.

Gamification design with the use points. Hew, Huang, Chu and Chiu (2016) conducted two experimental studies on the effectiveness of gamification in an Asian university. In the first study, 22 students who enrolled in a three-day blended course regarding questionnaire design were randomly divided into two groups. Both groups of students took the same course of which the activities were designed based on SDT, while only students in the experiment group experienced gamification design. In the second study, 43 students participated in the quasi-experiment study and enrolled in the same course in a longer version (18 days). Likewise, only the experiment group students experienced the gamification design. Points, badges, and leaderboard were used in the gamification design, specifically winning badges, which earned students points. Points were not associated with the final grade. The results showed that students in the gamification groups chose harder topics to learn that attached higher points, and students were more actively engaged in the online discussion, which could earn them badges. For the activities that were not attached to points, there was no significant difference found between the two groups in both studies. The result of the studies is interesting. The course activities were designed to satisfy students' competence, autonomy, and relatedness needs, so that engaging in the activities alone should satisfy students' three basic needs, thus, students would continue to engage in the course activities. However, the adding of the points did make a difference of students' engagement in the points related activities. In this case, points work as the positive feedback system to express students' ability and effort in the course, which serves the competence needs more effectively. However, since the courses in the two studies were relatively short, the gamification design's long term effect on learning engagement is not known.

Charles, Charles, McNeill, Bustard, and Black (2011) studied the influences of points on students' participation in computer degree courses. They implemented a points system in two different computer science courses. In study 1, 18 fourth year students participated in the points system version course for six weeks. The points were rewarded to students based on their participation level of attendance, completion of extra tasks, visiting WebCT (a learning management system), posting in the discussion boards, asking questions in class, and self-test quizzes. The researchers set a points cap for each of the categories, and informed students how they could earn 600 points with the upper limit of 700 points. The points are presented to students by the end of each class day in an anonymous leaderboard format. There was no control group to compare the effectiveness of the points system; however, the lecturer who had taught a similar course previously claimed that students were "more motivated to complete voluntary tasks, participated better, were prepared for class more thoroughly, and attendance improved" (p. 645).

In study 2, the participants were first-year college students who enrolled in a Java programming class. Similarly, Charles et al. (2011) assigned points to different course activities, including attendance, contribution to the tutorial, outstanding work, quiz revisions, group assignments, exam questions, and presentations. The difference from study 1 was the points were rewarded to groups instead of individuals. Additionally, the leaderboard was presented on a screen at the entrance to the department with each team's name on it. Positive effects were observed during the course; students on the same team discussed together their performance and made strategic decisions. Also, the retention rate increased compared to the previous semester where no points system was added. Furthermore, less students failed in the course; the distribution of scores indicated this design was most motivating to weaker students, although there was no significant difference found of the average scores in comparison with the previous year.

In Charles and colleagues' (2011) study, points fall into the category of granular and cumulative feedback, even though the points are not as immediate as in any digital games. The points cover almost all the activities that a student can put effort into in order to complete a course. More importantly, the points assigned to each activity are weighted to present its contribution to the learning achievements. These design characteristics give students clear instruction of what is expected of them. Additionally, two performance references, the total possible points and the leaderboard are provided for students to explain the meaning of the points. Finally, in the second study, there was teamwork between students, which promoted both competence needs and relatedness needs.

Along with the positive results of using a points system for students' participation in learning activities, there were also researchers that tried to use points to increase students' performance on certain academic tests. For example, Attali and Arieli-Attali (2015) studied the effect of points when adding them to a math assessment. 1218 adults participated in the study; they were randomly assigned to three conditions: points for accuracy and speed, points for accuracy and speed with a stress on accuracy, or no points. The results showed that there were no significant differences between accuracy in the three conditions, but the points showed a small effect on speed. They also implemented a similar study in sixth-eighth grade students. Students were randomly assigned to two conditions: points for accuracy and speed with a stress of accuracy, or no points. Similarly, response time of students in the points condition was shorter than the control group, while no significant differences of accuracy were found between the two conditions. In this case, points fall into the granular feedback category according to Rigby and Ryan (2011), which provides immediate feedback on the participants' performance of the math problem they just responded to. Though the accumulated points are presented on the math test interface, the meaning of the points on test performance was vague as there was no reference for the participants to compare with. Moreover, usually in studies applying SDT, the intervention provides the feedback or incentives to provide a needs satisfaction experience, so that the participants may want to do the task again in order to experience the satisfaction again. However, in Attali and Arieli-Attali's (2015) study, the points earned were dependent on the participant's math ability, which was not something that could be changed in a short, one-time math test session. Therefore, it is not surprising that there was no effect on test performance and only a minor effect on the speed.

Outside academic activities, gamification intervention has also been tested in physical activities. Ahn, Johnsen, and Ball (2019) examined points' influences on children's physical activity in a four-day quasi-experiment. 68 children were recruited from a summer camp and were assigned to either a points or no-points condition. Overall, there was no significant difference found between the two groups; however, children in the points condition outperformed their counterpart on the third day of the experiment. Moreover, the children in the points condition chose more low intensity goals in comparison with their counterpart, as the points were not weighed on the intensity goal they set for themselves, but depended on completion. There was no other reference provided for children to explain the points other than they could use the points to purchase tricks for the virtual dog that was their training buddy. The measures of the three basic psychological needs showed only significant higher relatedness needs satisfaction in the points condition. The points in this study were more aligned with the sustained and cumulative competence feedback, which rewards outcome instead of behavior. Ryan and Deci (2017) summarized, when rewarding to outcome, people tend to choose the short path to win the reward. In Ahn et al.'s (2019) study, children used the strategies that could win them more points with less efforts so they could see more tricks from the virtual dog. Therefore, only the relatedness needs were satisfied because their physical activity matters to the virtual dog.

Above are a couple of examples that used points in gamification designs. The mixed results showed that the design of the points was very important to the expected results. Points should be designed clearly in order to help students regulate their own behaviors based on the rewards offered. Points should be weighted based on the efforts needed in order to present competence accordingly. To reduce the chances of taking short cuts, the points should reward behaviors instead of outcomes. Additionally, points should be awarded to the tasks that can be achieved by putting in effort. For example, accuracy and speed were not something that could be changed during a one-time math assessment, while attendance can be improved during a six-week course. Finally, providing performance references is also important because it decides in what way students explain the meaning of points on their mastery.

Gamification design with the use of badges. Badges are another widely used competence-based gamification element in education. This section reviewed several badge studies with a focus on design and effectiveness from a PENS perspective.

Yildirim, Kaban, Yildirim, and Çelik (2016) used three badges in a 13-week face-to-face course that included 51 students. The badges in this study were designed as milestones but had no stake in the final grade. The content covered in every four weeks was associated with one badge. In the first week, students were informed the meaning of each badge and how to win them. This badge was a sustained competence feedback; in order to win the badge, students had to be successful in all the assessments and exams the badge included. Since the study did not include a comparison group, it did not know the relative effectiveness of the three badges on students' participation and performance. According to the qualitative interview data, the digital badges encouraged students to be proactive in their learning. The design of the badge also made students feel they were being recognized due to their mastery of the learning content. Therefore, it was fair to say that in this study, the badge winners' competence needs were satisfied.

McDaniel, Lindgren, and Friskics (2012) used badges in a semester-long online course. 138 out of 200 students completed the survey about the gamification design in the course. According to what the study had disclosed, the badges were rewarded to certain learning behaviors, such as completing the midterm and final exams early, or posting five constructive comments in the discussion board. There was also a leaderboard showing students' badges against those of their peers. Part of the final grade depended on the number of badges that students won. Not all of the badges were immediately visible to students, as some of them were hidden. Students had to search for the activities that won them the badges. This design feature made some students feel frustrated in the course. However, some other students revealed to the authors that they formed a Facebook group in order to determine how the hidden badges were rewarded. For students who joined the Facebook group, they experienced the search process as cooperative play, so that these students might experience the satisfaction of competence needs and relatedness. The authors admitted that some hidden badges were too difficult to achieve, so that they were not as motivating to most students as the authors had expected.

Fanfarelli and McDaniel (2017) continued the badge study in the same department in two other courses. There were 22 badges designed for the two courses in total, while only 18 types of badges were issued in the two courses eventually. All the badges were designed as “unexpected” and “skill-based” badges (p. 6). Both the badges and the criteria of earning the badges were hidden from students until they earned them. In addition, the winner of the badges had to demonstrate possessing certain skills or abilities; for example, completing an exam two days before it was due and achieve 90% or above in score. The number of badges earned by students had no stake in the final grade, and the students had no information about other students’ badge winning situation. The correlation analysis showed that the number of badges won by students significantly related to their final grade and course satisfaction. However, it had no significant relationship with the self-reported engagement level. Again, the hidden badge design did not worked as well as expected. The badges in this study were more aligned with the granular competence feedback, though not all of them were rewarded to students immediately after an action had been taken.

The last example of badge use was from German scholars Kyewski and Krämer (2018), who conducted an experimental study in an online course that attracted 324 students, with only 126 students in the data set. Students were assigned to three conditions. Students in one treatment condition could view their own badge, and students in another treatment condition could view both their own and peers’ badges. The control condition provided no badges. Though the course was a semester long, the experiment was only conducted in a five-week period in the beginning of the course. There were four badges in total, and one of them was hidden from students. The other three badges included participation in the discussion forum, top 20% peer feedback writers, and quiz performance (in three levels). Moreover, the description of each badge was not available to students, so that students had no information on how to win the badge. The badges had no stake in the final grade. The effect of the badges in the study was not as expected. First of all, students' intrinsic motivation decreased no matter which condition students were in. Students in the badge condition did not more actively log into the learning management system than the no badge condition students. Additionally, there were also no significant differences found between the quiz results and course grade. These results could be due to the implementation of the intervention. The manipulation check showed that only two out of 26 students claimed that they saw peers' badges, and 35 out of the 47 students reported they perceived their own badge. Finally, the 47 students in the two badge condition did not believe the badge signified they were top performers or that they progressed in the course. Also, they did not think it was important to them that the badges signified top performers or progress in the course. Since not all of the 126 students completed the questionnaire, the data set for each analysis was different. Despite the sample issue, the execution of the badge conditions could be one reason leading to the results. In addition to the hidden badge, students had no knowledge about the criteria of the other badges, which resulted in their disbelief of the badge's meaning and importance. Thus, the badge hardly represented mastery in their understanding.

The above four studies showed that in order to make the badges in a course motivate students' learning, they should be designed in a way that communicates clearly to students either how to win the badge or what competence the badge represents. Furthermore, even though finding hidden treasure is enjoyable in leisure games, in an educational context, it brings frustration to students—especially when the badge decided students' final grade.

Gamification design with the use of leaderboard. As mentioned in the above points and badges studies, the leaderboard could provide students information of their performance relative to their peers. The formats of leaderboard vary in gamification studies. Some leaderboards choose to only present a certain number of students' points, badges and rank, such as top five or ten, (e.g. Albuquerque, Bittencourt, Coelho, & Silva, 2017; Ding, Kim, Orey, 2017; Kuo & Chuang, 2016); others present only an individual student's points and the class average points (e.g. de Byl, 2013; Ding, Er, Orey, 2018). In addition, the items shown on a leaderboard can vary, including points, badges, or learning behaviors (Hanus & Fox, 2015; Landers & Landers, 2014). In most studies, the leaderboard was used to accompany other gamification elements. Fewer studies reported the effectiveness of using a leaderboard alone.

Landers and Landers (2014) presented top performers of various learning behaviors in the leaderboard, such as, the first three students who posted in the wiki, students who posted the most messages, students who wrote the best entries, and so on. In their study, they randomly assigned 86 graduate students to two conditions, with leaderboard and without leaderboard, in a semester-long course. Students in the leaderboard condition spent more time on the wiki projects, which led to higher quality of the wiki. In another study, Landers, Bauer, and Callan (2017) randomly assigned 240 students to four goal commitment conditions and one leaderboard condition to finish a brainstorm task in 12 minutes. The results showed that the effect of leaderboard on the performance was similar to setting a difficult or impossible goal, and higher than simple or self-decided goals.

In Landers and Landers' study (2014), the leaderboard was designed in a way that functioned as badges being available to both the student and others, which provides specific behavior expectations to students so that they spend more time on the course projects. In the later study (Landers et al., 2017), the leaderboard worked as setting a specific goal for one task; particularly, it functioned well as a harder goal. The two studies suggested the leaderboard as the points and badges should be designed in a clear way to inform students of the expectations of the course or the task, so that achieving it could satisfy students' competence needs.

In the studies discussed above, they all claimed that they adopted gamification design while the actual designs were so diverse that they left people wondering what on earth gamification design is. However, when examining the studies via the lens of the PENS model, it is clear that some gamification designs failed, as they were not designed in a way that could signify competence to participants and diminish the autonomy needs at the same time. Therefore, the positive feedback system should be designed in a way that signifies mastery and does not make the participants feel that they are being controlled. Some lessons from the above studies include attaching the rewards to the activity that can be achieved by putting efforts in; communicating the competence information to students in a clear way; weighing the rewards based on efforts needed; and providing performance references that help explain the meaning of the rewards.

Situated Learning Theory

When participating in online discussions, students tend to reach the minimum requirement only (Beckmann & Weber, 2016; Peters & Hewitt, 2010). Instead of proposing new ideas to communicate with peers, the major goal of participation is to not fail the course. Students' approach to dealing with course requirements could be categorized as setting themselves a performance-avoidance goal (Rawsthorne & Elliot, 1999). In other words, what these students pursue is to avoid doing poorly. As Ryan and Deci (2017) pointed out, it is the widely used school grading schemes that make students used to setting performance-avoidance goals.

Students in school settings were not only being taught subject matter knowledge, but also picking up tactics of surviving in the innumerable tests and evaluations. In the social cultural setting of schooling (in both face-to-face and online environments), students learn how to be a good student. Unfortunately, in a school that promotes tests and evaluations, being good means achieving an “A” or 100% in the grade book, or obeying rules, instead of being an active learner (Joubert & Wishart, 2012).

Learning how to manage evaluations is just one product of the grade emphasizing school culture; the gap between the knowledge learned from the classroom and the knowledge used in the practice is also a shared concern among educators (Brown, Collins, & Duguid, 1989). The knowledge that is transmitted, if successfully, to students is in the culture of school life, which pervasively use tests and evaluations to assess learning, as mentioned above. Students may be good at managing to pass the exams, but still are not prepared for their future work. In order to learn (not only pass exams), students need more than just concepts and examples in lectures and textbooks. As Brown et al. (1989) proposed, students “need to be exposed the use of a domain’s conceptual tools in authentic activity-to teachers acting as practitioners and using these tools in wrestling with problems of the world” (p. 34).

Creating an authentic activity is one approach—to have students interact with subject knowledge in tasks that require the use of concepts and skills. Practice field is a term used to describe this type of learning activities, which was first used in corporation trainings (Senge, 1984, as sited in Brab & Duffy, 2012). By definition, a practice field is not in the real field, but a separate environment where the learners can practice what they will encounter outside of the learning environment. Problem-based learning, anchored instruction, and clinical simulation were examples of creating practice fields in education, where students were responsible to propose solutions to an ill-structured problem. Barb and Duffy (2012) summarized several design principles of creating a practice field: “Doing domain-related practice; Ownership of the inquiry; Coaching and modeling of thinking skills; Opportunity for reflection; Dilemmas are ill-structured; Support the learner rather than simplify the dilemma; Work is collaborative and social; The learning context is motivating" (p. 36-37).

Games, particularly digital games, could be used as such practice fields for learning. This is also one endeavor of educational researchers who share interests in learning from game design. Games provide players a number of choices of characters, and in the process of becoming this character, players pick up necessary knowledge, skills and tools (Gee, 2003). The core feature of gaming is doing. Players learn to play the game by trial and error. They learn through their own performance and become good at what their characters are supposed to be. The game designers create game worlds full of challenges, which limited and shaped who the players could be and what they could do in the game system, but also let the players learn and master the game itself (Squire, 2006). Besides the positive feedback system and the challenges that have been discussed above, the narrative environment in the game system is indispensable in any massively multiple online role-playing games, as Dickey (2007) had summarized. It is within such narrative environments that points, badges, and leaderboards become meaningful feedback to the characters within the games; thus, players are willing to devote time and effort in gaming to conquer challenges.

Ramirez and Squire (2014) claimed that gamification is a good tool for rethinking the current schools where students don't have the chance to become anyone but "a good student" and submit great assignments to teachers. Thus, simply using the positive feedback system, as most studies did, cannot realize what Ramirez and Squire (2014) had expected, and is nothing but a makeover of the existing grading system. If gamification could become a new way to provide students more opportunities to be an active learner who can learn from authentic activities, the narrative environment that contextualizes the challenges should not be ignored.

Contextualizing PBL-gamification design in a practice field. Simply using PBL as the game mechanism to improve students' learning engagement has been criticized by some game researchers (Bogost, 2011). As discussed above, the current school culture has already used the achievement system, and it resulted in some unexpected results. Therefore, adding points or badges in courses may bring a spike of some desired learning behaviors, but eventually, it is learning that matters in any classroom. This leads to two design questions for the gamification designers: what behaviors can lead to effective learning in the specific course to be gamified, and how could the learning activities be designed to foster active learners instead of exam takers in this course. Rigby and Przybylski (2009) proposed the concept "learner hero" to describe a meaningful design approach to a virtual world for learning:

> By building a context of the player as a heroic actor, virtual worlds establish a highly facilitative environment for intrinsic need satisfaction. After all, heroes blaze new trails (autonomy), heroes master the challenges before them (competence), and heroes act in relationship with and for the betterment of the community (relatedness). In this way, it might be said more generally that the hero epitomizes self-determined functioning (p. 271)

Even though Rigby and Przybylski's (2009) discussion is in the game design context, it still inspires gamification design when applying it in the educational context. Linking the learner hero concept with the practice field could be a solution to improve PBL gamification design so that it could become an appropriate learning environment instead of another format of evaluation system in school life.

First of all, it is important to decide a practice field in the knowledge domain. Using Barb and Duffy's word (2012), the gamification designer should select an activity that the students could be doing as “domain-related practice” (p. 36). For example, a popular gamification system used in the K-12 context is *Classcraft*. In the gamification system, students can choose different roles with different skill sets. The roles include healer, warrior, and mage. The skill sets include trading places with other classmates, leaving classrooms for two minutes, handing in an assignment one day late, and listening to an iPod during classwork. These are some “skills” that could be convenient for student; however, they are not relevant to any domain knowledge, and the gamification system aims at reinforcing classroom regulations. In another example, middle school students teamed up as writers, editors, and historians to create essays on teenagers’ lives in the Great Depression in a STEAM curriculum (Cheng, Wu, & Koszalka, 2016). In order to create the essay, the seventh graders practiced writing, editing, information searching and analyzing, and collaboration skills.

Second, a practice field should be designed to immerse students in the authentic tasks. A narrative layer can be created through each game design element in order to provide immersion in a gamification design (Nicholson, 2015). Coherence of each gamification design element is important to achieve (Aldemir, Atas, & Celik, 2019). Therefore, a narrative layer could be an organized explanation of the gamification design elements that offers meaning to the gamification events (Fanfarelli, 2004). Therefore, the narrative layer of a practice field functions as an interpretation so that it helps students develop an understanding of the activities that they are about to do in a gamified course. The narrative should contain a start state, developments, and an end. The development of the narrative should result from students’ actions (Fanfarelli, 2004). Students co-create the whole “story” during the process, and develop a sense of ownership. Two design principles of creating a practice field that Barb and Duffy (2012) proposed could be applied here. First, the initial state of the narrative could be “ill-defined or defined loosely" (p. 37), so it leaves space for students to develop their stories. Second, students should be able to see that their endeavor makes a difference in the narrative development. Thus, they are part of the final artifacts and their effort counts.

By adding a narrative layer to a PBL gamification design, it contextualizes the positive feedback system in the targeted knowledge domain, and immerses students in the practice field by providing meaning to their actions.

Gamification design with the use of narrative. Few studies explore the effectiveness of narrative in the gamification context. One recent study is from Armstrong and Landers (2017); they investigated the influences of narratives on trainees' reaction and learning. 237 participants from various industries were randomly assigned to two conditions of a laptop security practice training: the original self-paced training materials and the gamified training materials. The treatment materials were based on the original materials but with the addition of a setting, theme, and plot. In other words, the treatment group training materials were integrated into a narrative. The results showed no significant differences in the declarative knowledge between the two groups. However, trainees in the control condition (original materials) performed better in a procedural knowledge test, but were much less satisfied about the training materials compared to trainees in the treatment condition.

In this study, the narrative that the authors added to the training materials altered the writing style by adding fictional scenarios. However, it should be noted that the trainees in the treatment condition were not involved in the development of the narrative. According to the discussion of narratives above, adding a narrative layer to the instructional content should put learners in a situation where they can practice knowledge and skills, and their actions move the narratives forward rather than simply presenting the content in a fiction/story format. Moreover, the authors speculated that the negative results on learning could be due to a lack of other game elements, such as challenges. The changes of the writing styles of the materials did not provide the trainees any additional interaction with the content; they still just read the materials.

Aldemir, Celik, and Kaplan (2018) gamified an instructional technology course with the use of PBL and narratives. The narrative they used in the course was a "fantasy-focused coherent context" (p. 239); similar to *Harry Potter*, students were divided into four houses. Students collaborated with their housemates and competed with the other houses. In a qualitative analysis from student interviews and course artifacts, the authors summarized that more than half of the students did not like or understand the narratives. One reason of the negative attitudes toward the narrative was lack of relevance. The narrative in this study is similar to the *Classcraft* discussed above, it may add novelty to the course, but it is not relevant to the domain knowledges. Though the authors (Aldemir et al., 2018) discussed the relevance problem from a perspective of student interest and familiarity with fantasy fiction, as many other literatures suggested, the narrative should be content relevant and assist building a practice field rather than adding only a fun element. Both studies show that altering the writing styles of learning materials or adding a fantasy fiction setting may not benefit learning. It is the domain-relevant practice field that a narrative layer should be an addition to.

The reviewing and analyzing of the literature on situated learning theory and attempts of using narratives in gamification proposes a solution to one gap in the gamification research: the appropriate relationship between the motivation design and the instructional design. What the motivation design (in this case gamification design) motivates students to do in the course should be thoughtfully planned in the overall design of the instruction. In other words, motivation design encourages students to participate in the instructional/learning activities, while it is the instructional design that decides whether learning will happen by doing these activities. In this study, I proposed to first design the course that involves domain-relevant practice, then create the gamification design elements that are contextualized in the practice field through a narrative layer.

Summary of the Literature Review

The concerns of low participation and low quality in online discussion were shared by the online learning researchers. While there were different approaches to improve the problems, the study intended to use gamification to motivate students to participate and maintain the participation in the online discussion forums. The reviews of gamification studies showed that the various designs of the gamification elements brought different outcomes in terms of learning behaviors and final grades. The PENS model (Rigby & Ryan, 2007) shed light on the selection and design foundations of gamification elements in the educational context. Furthermore, Ramirez and Squire (2014) proposed a higher expectation for gamification: to provide students a learning experience that prepares them for their future work. Using a narrative environment to contextualize the gamification elements to create a practice field seems to be a promising way to deliver such learning experiences. More empirical studies with such design foundation should be conducted to examine its effectiveness in the online learning context.

Chapter 3 Method

The purpose of the study was to create a gamification design model in order to investigate its influences on students' interaction in the discussion forums of an online course. This investigation was achieved by using a design-based research approach. Students' interaction and gamification performance from the three design versions of the course were compared with each other, and students' experiences in the revised gamification design were examined. The following research questions were asked:

RQ1. What are the patterns of students' interaction in the online discussion forums of the gamified courses in terms of quantity, interaction dynamic, and interaction quality?

d) How frequently do students post in the discussion forum of the course?

e) What is students' interaction dynamic in terms of Social Network Analysis (SNA) measures?

f) What is the distribution of the knowledge building phases of students' discussion?

RQ2. Compared to the baseline year (the NGC, non-gamification version of the course), does students' interaction in the online discussion forum change in terms of a). quantity, b). interaction dynamic, and c). interaction quality?

RQ3. How does gamification design influence students' interaction in the online discussion forums?

c) Are there specific gamification events (points update, leaderboard update, etc.) that influence students' interaction performance?

d) What is the variation among students' interaction under the influences of each gamification event?

Research Context

The study site was a private research university in the Northeastern region of the U.S. The course used in the study was a three-credit graduate-level course about educational technology. The course was entirely online in the summer semester, running for six weeks; no synchronous session was required. All the course materials distribution and assignment submission were through Blackboard, a learning management system used at the university.

In the NGC, students are required to finish a “book chapter” about educational technology in the country they select individually. To help students finish the book chapter, the project is composed of two sub-tasks, an initial proposal and a final book chapter. Additionally, two other essays are assigned during the course. One essay is about the issues implementing educational technology projects in other cultures. The other essay is a regional picture about the country that students choose to write about. Students are encouraged to use the two essays in their final book chapter. They are required to submit the book chapter on the last day of the course.

To compensate for this highly individual writing project where students only study one country, they are required to participate in an online discussion forum on a weekly basis. For each discussion question, students have only one week to respond. They are required to make one initial response to the discussion question and at least one comment to other students’ messages. In the first two weeks, the online discussion is initiated by the course instructor who selects and posts weekly readings, and creates discussion threads with the discussion questions. In the following four weeks, the responsibility of selecting readings and creating discussion questions is transferred to students. Both selected readings and discussion questions are required to be sent to the instructor before the beginning of the assigned week, and the instructor checks the materials to ensure their quality. Moreover, students are required to facilitate the discussion thread. They are grouped based on the country they selected, and they can collaborate with group members to create questions and facilitate discussion for the assigned week. They are encouraged to use prompts and follow-up questions to stimulate the continuance of the discussion.

Participants

Participants were students who had taken the targeted course in summer 2016, summer 2017, and summer 2018. Over the three years, a total of 51 students enrolled in the course; two of them took an incompletion(one from 2016 and 2017 respectively); one student dropped the course before it started (from 2018), so they were excluded from the study. 24 of them enrolled in the NGC in the summer of 2016. The students were divided into two groups (13 and 11) in the NGC due to the larger class size. Students only had access to interact with their peers in their own group. One student took an incompletion of the course and was excluded from the sample. 14 students enrolled in the PGC (the prototype gamification version of the course) in the summer of 2017; one student took an incompletion of the course and was excluded from the sample. 13 students enrolled in the RGC (the revised gamification version of the course) in the summer of 2018. There were 49 students in total in the following analysis. Nine out of 13 students in the RGC agreed to participate in the semi-structured interviews after the course, while eight students eventually completed the interviews.

When students took the course, they were all enrolled in an education related master's or doctoral degree program. The majority of the students were domestic students (73.4%) and were master's students (89.9%). This information was extracted from the self-introduction threads that students posted in the first week of the course.

Table 2 *Basic Demographic Information of the Participants*

	Non-Gamification Course (NGC, 2016)	Prototype Gamification Course (PGC, 2017)	Revised Gamification Course (RGC, 2018)
N of Participants	23	13	13
N of International Students	5	2	6
N of Doctoral Students	2	3	0

Research Design

A Brief Introduction of Design-Based Research

This study uses the design-based research (DBR) method, conducting a two-iteration design case of gamification in the online course described above. In 1991, DBR was introduced to the education research field by Brown (1992, as cited in Cobb, Jackson, & Sharpe, 2015) and Collins (1992, as cited in Cobb, Jackson, & Sharpe, 2016) in order to balance the issues between basic research and applied research. DBR "blends empirical educational research with the theory-driven design of learning environments [and] is an important methodology for understanding how, when, and why educational innovations work in practice" (Design-Based Research Collective, 2003, p. 5). In other words, DBR is not only used to create and test an innovative learning/teaching intervention, but also to deepen the understanding of the learning process in the context.

DBR is a highly interventionist methodology (Cobb, Jackson, & Sharpe, 2015). Though a DBR study is usually implemented in a specific practical setting, the cases of interest should belong to "a broader class of phenomena" (p. 5). By doing so, the analysis of the cases can help to generalize the design and develop theories. One feature that distinguishes DBR from the laboratory research method is the environment where the study is conducted. As mentioned above, DBR studies are usually conducted in real-world settings. Rather than using a vacuum lab environment to eliminate alternative explanations in the most basic research, for DBR, the designed intervention usually aims to solve a practical problem in a real educational setting with the consideration of contextual factors. It is unavoidable that these context factors may influence the outcomes. Therefore, the intervention design within DBR studies should be responsive to these environments' "noise." Additionally, it is necessary to document both the learning process and the developing learning environment during the intervention in order to address the targeted issues from theoretical perspectives (Cobb, Jackson, & Sharpe, 2015). More importantly, multiple iterations are common and needed in DBR to refine the design and advance the theory (McKenney & Reeves, 2012). Figure 1 showed a generic model of DBR in the educational field.

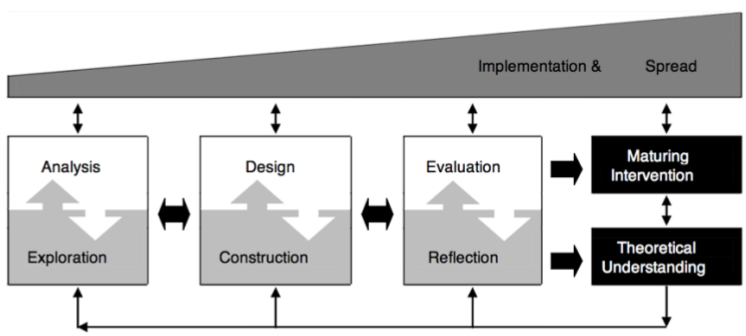

Figure 1 *Generic Model for conducing Design-based Research (McKenney & Reeves, 2012)*

Rationale of Applying DBR in the Study

The purpose of this study is to create a gamification design and examine its influence on students' interaction in an online discussion forum. First of all, this study intended to propose a solution to a practical problem: low participation and low quality of students' interaction in online discussions of online courses (Guzdial & Caroll, 2002; Romiszowski & Mason 2004;

Salmon, 2003; Wise et al., 2012). Such performance problems can jeopardize the potential benefits of learning from students' interaction expected by educational researchers and practitioners (Joubert & Wishart, 2012). Online discussion is a common practice to promote students' interaction (Hou, 2011); it is usually accompanied with other instruction/learning activities (video lectures, quizzes, project, essays, etc.) in the online course and is delivered through various learning management systems. These environment factors could account for the effectiveness/ineffectiveness of any proposed interventions (Cobb & Gravemeijer, 2008). Thus, when studying any intervention in online learning environments, it is appropriate and important to document the environment factors that either support or impede the students' interaction.

Second, the choice of adding a systematic motivation layer through gamification design had its theoretical foundation (Ramirez & Squire, 2014; Ryan et al., 2006). The gamification design applied in the study was originated from the Playing Experience of Needs Satisfaction (PENS) model (Rigby & Ryan, 2007), which describes the features of successful digital games from a self-determination theory perspective. Moreover, the study proposed to add a narrative environment to contextualize the selected gamification elements in the content domain area from a situated learning theory prospective. The design and research iterations could help to test and refine the application of the proposed design framework. At the same time, the three types of measures of students' interaction were carefully selected from previous research in online learning environments (Gunawardena et al., 1997; Lucas et al., 2014; Nandi et al., 2011; Phirangee et al., 2016; Wise et al., 2012a, 2012b, 2013). The in-depth analysis of students' interaction can enrich the understanding of students' online learning behaviors in a gamification context.

Finally, the study intended to propose a gamification design model with a focus on improving learning behaviors in an online education context. Though there are a number of studies that implemented the so-call gamification intervention in online courses, the various design failed to lead to a firm conclusion of gamification's impact. By following a DBR approach, on top of proposing a generic design model to help future researchers and instructional designers to select, design, and contextualize gamification elements in their own online learning environments, this study also documented the design process with both theoretical foundations and empirical evidence, which can help the readers gain insight into the proposed design model.

Table 3 *Design and Research Procedure for this study*

Time	16 Summer	17 Spring	17 Summer	17 Fall & 18 Spring		18 Summer	18 Fall & 19 Spring
Design Iterations		Analysis Exploration Design	Construction Implementation	Evaluation Reflection	Analysis Redesign	Construction Implementation	Evaluation Reflection
						Micro-Analysis	
	NGC		PGC			RGC	
Research Iterations		Literature review and analysis	Data Collection (16&17)	Data Analysis Findings Suggestion for revision		Data Collection (18)	Data Analysis Findings Conclusions

Gamification Design Iterations

The two iterations of the design and research process in this study were presented in Table 3. The first gamification design cycle started with the problem analysis and the intervention exploration. The results were presented in Chapter 1 and Chapter 2. Based on the review and analysis of the previous literature, I chose to use self-determination theory and situated learning theory as the theoretical foundation for the gamification design model in this study. After implementing the prototype of gamification design in the summer of 2017, students' interaction data and gamification performance were collected and analyzed. As suggested in McKenney and Reeves' generic DBR model (2002, Figure 1), findings from implementing the prototype design were used to guide the gamification design revision from theoretical perspectives, and were also used to address the implementation issues. The positive influences and the issues identified in the design framework and implementation plan were both taken into consideration in the second design iteration. The revised gamification design was implemented in the summer of 2018. In order to assess the immediate effect of the revisions, a micro-analysis of students' gamification performance and interaction in the discussion forums in the first week was conducted in the second iteration; the findings were used to adjust the revised gamification design.

Next, I briefly introduced the gamification design in the two iterations. The final design product and the design process are documented in Chapter 4. Appendix I is a summary of the design specifics of the two design iterations with a comparison to the non-gamification version of the course. Conjecture mapping in DBR is one approach to "reify specific conjectures and how they are expected to function in interaction to promote learning" (Sandoval, 2014, p. 20). Appendix II presents a summary of the learning and design conjectures in this study. Based on the test and analysis of the prototype design, the design conjectures were also revised in the second study iteration.

Prototype gamification design. The gamification design in the study was an endeavor to replicate a game's "power to engage" (Rigby & Ryan, 2011, p. 10). Ryan and his colleagues investigated the attraction of gaming from a psychological perspective based on self-determination theory (Ryan et al., 2006). Their finding showed that successful games usually fulfill people's three intrinsic needs: competence, autonomy, and relatedness, so that gamers are able to experience positive feelings and keep engaging in gaming. Then Rigby and Ryan (2007) proposed the PENS model to describe the features that successful games shared, to guide the game design process. The prototype gamification design was designed to fulfill the three psychological needs in order to keep engaging students in the discussion forums. The prototype gamification design included a positive feedback system and a narrative environment where students were assigned roles as regional specialists and were expected to be trained in the summer camp to write a book together.

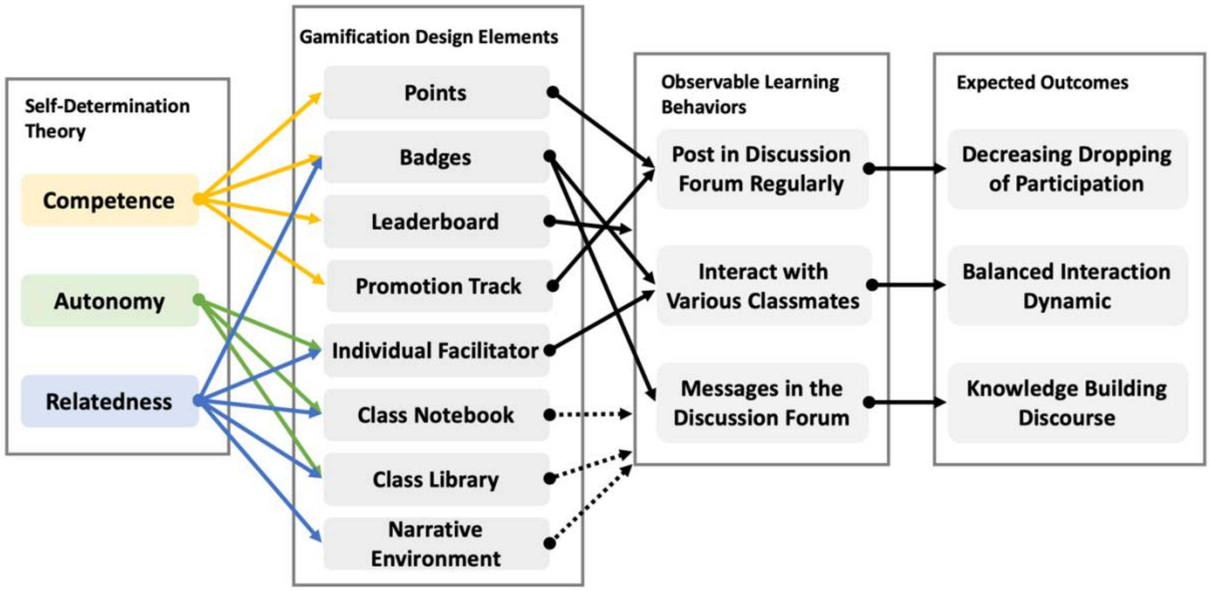

Figure 2 Prototype Gamification Design Framework

Competence: A positive feedback system and optimal challenges. To satisfy students' need of competence, the prototype gamification course provided students a positive feedback system to document and demonstrate their progress in the course. Each student had a personal page in the Blackboard course site where they could check their accumulated points and records from previous updates.

Points were named as experience points in the prototype design. The experience points were a reward for task completion. As any learning related behavior could be seen as students' efforts put in learning the course content, participation within the time limits earned students experience points. For example, each discussion thread only lasted for one week, and students had to post messages before it was closed to earn experience points.

Badges were another way to provide students opportunities to present competence. Different from experience points rewarding completion, a badge was an award for extraordinary performance. Only students who out performed their peers won the badges. Two of the five badges were for the two essay assignments winners. The other three badges were designed for the online discussions. One was awarded to a peer-evaluated best message in each week. The second one was awarded to students who sent comments to a variety of students. The last one was awarded to students who received comments from a variety of peers.

A class leaderboard was provided to students in Blackboard, and it was updated twice a week. It presented each student's accumulated experience points and the badge winners of the week. The leaderboard presented the country name of students' selections to represent them.

The promotion track was a level system in the prototype design that connected the final participation score with the experience points in the course (up to 40% of the final grade). Once students reached certain experience points, they were leveled up to the next title.

Autonomy: Adequate level of choices. Compared to any digital games and virtual world simulations, students usually had limited options—at times even zero—in a typical classroom. They were required to participate in class activities and finish assigned homework to complete the course. To address the autonomy needs, the prototype gamification design provided various class activities for students to gain experience points with no minimum requirement but a maximum limit for each activity in a week. For example, given that students might prefer a more independent learning approach, sharing reading notes could earn experience points in addition to posting on discussion forums.

The original course provided choices by allowing students to select the country they would like to write about, to choose reading materials, and to propose discussion questions. The prototype gamification design kept these elements.

Relatedness: You matter. In the prototype design, each student was assigned a role as a regional specialist. They started from the lowest level as a candidate for the specialist position. By participating in the activities, they earned experience and would be promoted to higher levels. The regional specialists were expected to contribute their professional knowledge to the community; therefore, they selected essential readings to help their peers to develop an understanding of their countries, and proposed meaningful discussion questions regarding the major issues in their countries. Besides autonomy, these activities also tried to satisfy students' relatedness needs by informing students of the influences of their behaviors on the whole class.

Moreover, the prototype gamification design tried to satisfy the relatedness needs by creating a decentralized interaction pattern to reduce the opportunities of feeling left out in the discussion. Therefore, three out of the five badges set clear behavior expectations in the discussion forums to promote even and broad interaction between students. As students tried to reach the goals set by the badge, they built meaningful connections with various peers.

Implementation plan. The gamification setting was presented in a Google site (https://sites.google.com/view/ide7722017summer/home). The link to the Google site was in the course syllabus and was sent to students in the first day of the course. Students' participation data in the discussion forums and in the class notebook were documented on Blackboard. I used these data to calculate students' experience points and updated it every Monday and Thursday during the six weeks. Students received an email notification of each update. The badges were issued through the achievement system in Blackboard; each student could view how many badges they had earned or not earned. The peer evaluation activity was delivered by using the rating feature in the discussion forum. Students could give any message posted in the discussion forum stars (from one to five).

Revised Gamification Design. Based on the implementation of the prototype design, some adjustments were made in the revised version. The process was shared in Chapter 4. The adjustments were in three aspects: the conceptualization of the narrative environment, the operationalization of several gamification design elements, and the implantation plan.

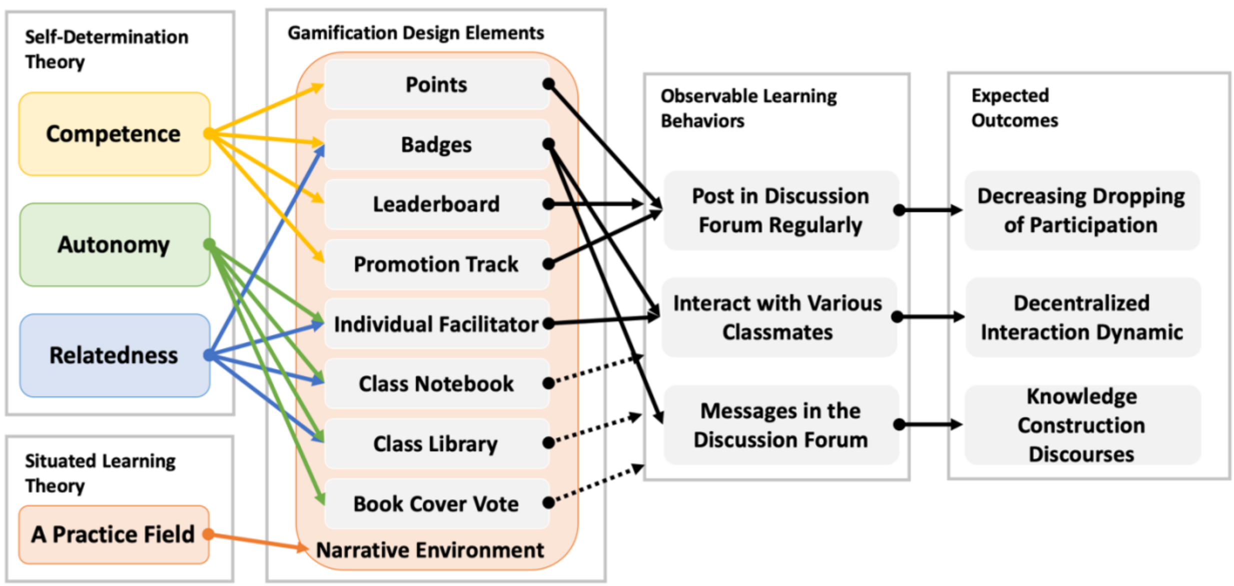

Figure 3 *Revised Gamification Design Framework*

The conceptualization of the narrative environment. In the revised gamification design framework, the narrative environment was not only used to set the theme of the gamification design, it also developed based on students' actions. The enhanced narrative environment intended to transform the course into an authentic practice field. Though the analysis of the interaction data in the prototype gamification design version of the course showed promising results, the week-to-week data indicated a sharp decrease in the last week, which was not observed the in non-gamification course. Moreover, the experience points almost stopped increasing in the last week. It was possible that students shifted their focus to the book chapter project in the last week. It brought concerns that the discussion forum and the book chapter project competed for students' time instead of working as a compensation for each other in terms of the course content. Therefore, these findings led to the new conceptualization of the narrative environment, which should spread over the course with developments resulting from students' actions and a finale instead of being an individual element occurring only at the beginning of the course.

The operationalization of several gamification design elements. The participation rate of the peer evaluation activity for deciding the best speech was rather low. In order to improve students' participation, in the revised gamification design, the peer-evaluation was delivered through a Qualtrics survey instead of the embedded rating system in Blackboard.

The new deliverables of the narrative environment were added. In addition to the initial email, during the course, students needed to vote for the book cover. After written assignments were graded, students were able to read their peers' book chapter pieces so that they were informed and reminded that the book was in progress. Finally, at the end of the course, the students received an electronic version of the book with the cover they selected.

The implementation plan. As the course only lasted for six weeks, it was very dense in terms of course content and activities. Especially in the beginning of the course, students needed to learn both the content materials and the gamification settings, which added extra work for students. Therefore, in the revised version, the gamification settings were delivered to students three days before the course started as a pre-course activity. In this way, students could focus on the course content in the first week, instead of learning both gamification rules and learning materials. Instead of using a Google site, the gamification settings were written in a section in the course Blackboard site to make it more accessible to students.

Research Iterations

Accompanying the two design iterations, the study investigated the gamification design model systematically by employing an embedded mixed design (Creswell & Plano Clark, 2007). The quantitative data were collected and were used to answer the questions regarding the effectiveness of the proposed gamification design model. Qualitative data as a supported role in the study examined the mechanisms of the gamification design model.

The study applied gamification design to improve students' interaction in the discussion forum. Theoretically, when students' three basic psychological needs (competence, autonomy, and relatedness) were satisfied by engaging in the course activities, they should maintain their active level in the course in order to keep the feeling of satisfaction. To test the theoretical reasoning, the empirical evidence in this study came from the comparisons of students' interaction in each design cycle. Then, the study could associate the changes in the students' interaction with the different versions of the course design. To further provide warranty for the association of changes and the intervention, students' gamification participation data were also documented and compared.

In addition to the quantitative data of students' interaction and gamification participation used to test the effectiveness of the gamification design, the study also collected qualitative semi-structured interview data that explored students' experiences in the revised gamification design. The reason for collecting this set of data was to address the research questions of how each gamification event influenced students' interaction in the discussion forums, and whether the gamification design satisfied students' competence, autonomy, and relatedness needs. The study invited all the students who completed the revised gamification version of the course to participate in the semi-structured interview. While nine out of 13 students agreed to participate, only eight students finished the interviews.

Measures for Students' Interaction. As improving students' interaction was the goal of the study, how to measure and evaluate students' interaction was of import. In this section, I described the set of measures of students' interaction for this study.

Message quantity. The most common and direct quantity measure of students' interaction in online discussion was the number of messages during a certain time period. Researchers could develop detailed understanding of patterns of student posting behavior based on this type of information.

Time stamps are one kind of information that are provided by any learning management system. Some researchers use the information to describe students' online learning behaviors. Examples of behaviors related to a time stamp in an asynchronous discussion forum are: when students post in the discussion forum (Skogs, 2013), what the posting pattern is during the targeted time period (week, month, or semester) (Cheng-Huang & Chow, 2013; Yücel & Usluel, 2016), and how the number of posts changes over the targeted time period (Yücel & Usluel, 2016). Also, the changing patterns of posting over a period can help researchers to narrow down the reasons for the fluctuation, such as whether the difference in post numbers is because of the quality of discussion questions or the moderator of the thread.

This study focused on the number of messages that students posted at both the weekly and semester scale. The message sum in a semester revealed the overall participation level and the weekly message sum displayed how student activity level changed during the semester.

Interaction dynamic. Even though the quantity of messages that students post can illustrate students' interaction in online discussions in general, it lacks information regarding students' connectedness. SNA looks at relational data of students' posting behaviors in online discussion forums, which provides elaborate information about the interaction between students. SNA is a popular approach for researching social relations and network structures (Prell, 2012). SNA has been used in social economic study, social anthropology, social structure, interpersonal relationship and cliques, and other social science areas for a long time (Prell, 2012; Scott, 2000). In recent years, SNA has been adopted by more and more researchers to study networked behaviors in online learning environments (Cela, Sicilia, & Sánchez, 2014). Based on a systematic review of SNA in online environments, Cela et al. (2014) claim that SNA is an effective method to describe online networks quantitatively and to measure the degree of interaction. Particularly, when using SNA to study online discussion forums, it helps to extract patterns of interaction between students, and generate characteristics (information flow; sub-community, etc.) of the discussion process (Wise, Cui, & Jin, 2017)

SNA measures. Centrality measures portray the position of each member in a group; they are especially important for evaluating network structure in terms of knowledge construction process. At an individual level, centrality shows the position of a member. Local degree centrality shows the number of group members adjacent to one member. In a direction network, in-degree centrality is the number of ties received by one member from others. Out-degree centrality is the number of ties given by one member to others (Prell, 2012). In-degree is frequently used as a measure for popularity, and out-degree is often used as a measure of expansiveness (Prell, 2012). In the context of online discussion, in-degree of one student is the number of students who send him/her comments, and out-degree is the number of students that one student send comments to. The value of the two local degree measures was limited to the size of the group. For a larger group size, it took a student more time and energy to connect with others. To be able to compare the in-degree and out-degree between the three versions of the courses with different class sizes, I used the measures that represented the percentage of peers that a student had interacted with (in- and out-) in one group (Freeman, 1979). The student with a higher value of in-degree and out-degree measure is in a more central position in the group. At the same time, this student is also in the middle of other members and has the closest distance to other members mathematically.

Reciprocity “is an index for measuring the tendency of actors to reciprocate” (Zhang, Liu, Chen, Wang, & Huang, 2017, p. 8); it is the ratio of mutual dyads to non-null dyads in a network (Ouyang & Scharber, 2017). A dyad is composed of two group members and the ties between them (Prell, 2012). For all the dyads in a given network, there are three states: mutual, asymmetric and null. A mutual dyad is when the two members both send a tie to each other. An asymmetric dyad is when only one member sends a tie to the other. A null dyad is when no tie exists between the two members. In the context of a discussion thread, when the tie is defined as “speaking” to, a mutual dyad is a complete information loop (Yacci, 2000).

Density of a network is calculated as the ratio of the actual ties in a network to the total potential ties in the network (Prell, 2012). Density represents the connectedness of the network. It is widely used in online interaction studies. Fahy et al. (2001) mention that researchers should be cautious when using density to represent how well a group of students are connected. The high value of density might be due to a small group of students reaching to all members instead of a more mixed connection. Therefore, Fahy et al. (2001) suggest to use density as well as degree of centrality to gauge the connectedness. Centralization scores were based on degree centrality and described the whole group centrality. A centralization score was calculated as "the variation in the degree centrality of the actors is divided by the maximum possible degree centrality variation" (Prell, 2012, p. 169-170).

Interaction Quality. Content Analysis is a common method used in studies of students' interaction in discussion forums of online courses. In a review, De Wever, Schellens, Valcke & Van Keer (2006) summarize 15 content analysis schemes for studying transcripts of online discussion forums. In the study, I chose to use Interaction Analysis Model (Gunawardena et al., 1997) to analyze message function in terms of knowledge building in the online discussion.

Interaction Analysis Model (IAM). Interaction Analysis Model is developed by Gunawardena, Lowe and Anderson in 1997, which is one of the most commonly used instruments for analyzing the knowledge construction process through computer mediated communication (CMC) (Lucas et al., 2014). IAM emerges when the authors analyze a computer mediated debate through listserv. They find that within the interaction among all participants, "negotiation of meaning and co-creation of knowledge occurs" (p. 407). Their model is rooted in social constructivist principles. Through meaning negotiating, participants discuss and contribute knowledge in order to come to a common understanding as a group. By using the grounded theory approach, Gunawardena and colleagues (1997) proposed a 5-Phase model to describe the knowledge building process in CMC.

In IAM, the first phase is sharing and comparing information, followed by the discovery and exploration of dissonance or inconsistency among ideas, concepts or statements. The third phase is negotiation of meaning/co-construction of knowledge. The next phase is testing and modifying the proposed synthesis or co-construction. Finally, in the last phase, participants agree on the statements/applications of newly constructed meaning. When applying IAM, the unit of analysis is usually a message.

Table 4 *Interaction Analysis Model (Gunawardena et al., 1997)*

Phase		**Definition**
PHASE I: SHARING/COMPARING OF INFORMATION	1A	A statement of observation or opinion
	1B	A statement of agreement from one or more other participants
	1C	Corroborating examples provided by one or more participants
	1D	Asking and answering questions to clarify details of statements
	1E	Definition, description, or identification of a problem
PHASE II: THE DISCOVERY AND EXPLORATION OF DISSONANCE OR INCONSISTENCY AMONG IDEAS, CONCEPTS OR STATEMENTS	2A	Identifying and stating areas of disagreement
	2B	Asking and answering questions to clarify the source and extent of disagreement
	2C	Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view
PHASE III: NEGOTIATION OF MEANING/CONSTRUCTION OF KNOWLEDGE	3A	Negotiation or clarification of the meaning of terms
	3B	Negotiation of the relative weight to be assigned to types of argument
	3C	Identification of areas of agreement or overlap among conflicting concepts
	3D	Proposal and negotiation of new statements embodying compromise, co-construction
	3E	Proposal of integrating or accommodating metaphors or analogies
PHASE IV: TESTING AND MODIFICATION OF PROPOSED SYNTHESIS OR COCONSTRUCTION	4A	Testing the proposed synthesis against "received fact" as shared by the participants and/or their culture
	4B	Testing against existing cognitive schema
	4C	Testing against personal experience
	4D	Testing against formal data collected
	4E	Testing against contradictory testimony in the literature
PHASE V: AGREEMENT STATEMENT(S)/APPLICATIONS OF NEWLY CONSTRUCTED MEANING	5A	Summarization of agreement(s)
	5B	Applications of new knowledge
	5C	Metacognitive statements by the participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction

Lucas et al. (2014) reviewed studies (2006-2011) that used IAM. They found the studies were all in the context of higher education or post-graduation, including students from undergraduates to in-service teachers. The majority of platforms in these studies were the discussion forums. Therefore, it is appropriate to apply IAM in the discussion forum in the study.

There are variations when using IAM, such as studies that only code messages in the five phases (Yücel, & Usluel, 2016; Zhang, Liu, Chen, Wang & Huang, 2017), and studies that use partial sub categories (Zhang & Zhang, 2010). According to the purposes of the study, some researchers add social dimensions when using IAM. For example, in Hou and Wu (2011), they add Task coordination and Social interaction in addition to knowledge construction. Yücel and Usluel (2016) add a quality assessment framework examining messages' contribution and relevance to the discussion. Social identity is added to Goggins et al.'s study (2016) to examine the dynamic of knowledge construction in different types of groups. In this study, the transcripts of students' interaction were coded by using the sub-phases within IAM and the non-academic related content was coded as another category of Non-Academic.

Gamification Participation Data. Gamification participation data intended to describe students' reaction to the various gamification activities and the coverage of the rewards. The gamification participation data in this study included the experience points sum and its composition; the number of badges issued and the badge winners; the climbing process on the level system; and the click stream data of the leaderboard page and the personal page.

Semi-Structured Interview. The semi-structured interviews were conducted at the end of the RGC in the summer of 2018. The full interview protocols were in Appendix IV.

The semi-structured interview included several parts: students' previous experience of taking online courses, students' previous experience with gamification, students' experience with each gamification element in this study, and students' expectation before the course and overall feelings at the end the course.

The interview starting with students' previous experience of online courses was intended to help the interviewees to warm up for the rest of the interview. Asking students their expectations before taking the course revealed whether they had particular motivation to take the course.

In the next section, the interview focused on the revised gamification design. For each gamification design element, the interviewees shared their understanding, opinion and comments. Moreover, they were also asked to share whether they did anything particular to try to win the reward. Some questions were formed specific to the interviewee by drawing information from the gamification participation data, for example, their click frequency of the leaderboard and the personal page, their participation of the peer evaluation.

In the last section, the interviewees were asked about their overall feelings about the course. The focus was about the sense of success, the workload, and connection with peers. Finally, students were asked about their previous gamification experience and their explanation of gamification to someone else.

Data Collection and Analysis

Data Source and Collection

All the data used to evaluate the influences of gamification design on interaction in this research are archived Blackboard data, including course log data generated by the Blackboard system, and students' participation data in the discussion forum. To further explore the influences of gamification events on students' interaction, gamification data generated by the researcher was collected. Semi-structured interviews were conducted to collect students' perspectives in the second iteration. Data was collected by the researcher during and after the end of each course.

Table 5 *Data Sources*

Data Category	Description	Purpose
Demographic information	• Bio-info students post in the self-introduction thread	Describe sample
Course log data	• Number of messages in the discussion forum of each student daily • Number of times clicking leaderboard and points section of each student daily • Number of notes in the class notebook and the contributor of each note	Evaluate participation in interaction

Students' interaction data in the online discussion	• Students' interaction data in each thread
	    o Reply-Comment Behaviors
	    o Depth
	    o Date published
	    o Length of message
	• Discussion Transcripts
		Evaluate interaction dynamic and interaction quality

Gamification data	• Accumulated experience points of each student, twice a week • Rank of students, twice a week • Badges winners, once a week, occasionally twice a week	Investigate the influence of specific gamification events on students' interaction
Semi-structured Interview	• Audio recordings and text transcripts of semi-structured interviews	

Course log data. Course log data was downloaded by the researcher from Blackboard each week during and after the course ended, and saved as Excel files. The two kinds of files are compared to ensure their accuracy. Since Blackboard used in the research site only saved the log data for 180 days, there were no log data available for the non-gamification version of the course. The log data downloaded for the two gamification versions of the course included the number of messages posted in each discussion forum, the number of notes and their contributors in the class notebook, and the click stream data of the leaderboard page and the personal page. Particularly, for the revised gamification version of the course, the time students spent on the Blackboard course site before the course started was also collected. Unfortunately, part of the click stream data in the prototype gamification course was lost due to a technological issue. The data of the two students who took an incompletion in the non-gamification version of the course and the prototype gamification version of the course were eliminated from the downloaded log data.

Discussion forum data. The discussion forum was the major data source of the study. In each version of the course there were eight major discussion forums created over the six-week course period. Besides the six discussion forums, there was one self-introduction forum where students could post their bio threads in the first week and one question forum for students to ask questions related to the course or the use of Blackboard. Students' self-introduction posts were collected, but the self-introduction and the question forum were not included in the students' interaction data.

For each thread in the six weekly discussion forums, the reply-comment structure, the depth of each message, the date that the message was published, the length of each message, and the transcript of each message were recorded. Since the study focused on the students' interaction, any reply-comment structure that included the instructor was eliminated from the data set. In addition, any reply-comment structure that included the two students that were excluded in the sample was also eliminated from the data set. Any self-loop (replying to him/herself) was removed from the data when calculating the SNA measures.

Since the Blackboard log data was not available for the non-gamification version of the course, the number of messages posted by each student in each week and in the discussion forum was generated from the discussion forum data by using the Count function in Excel.

Gamification data. Gamification data was calculated by the researcher by using course log data. Experience points for each category of each student in each week were saved in an Excel file. The ranks and badges of each student were saved as Word documents during the course and were transferred to an Excel file after the course.

Semi-structured interviews. Semi-structured interviews were conducted after the end of the revised gamification version of the course. Nine out of 13 students indicated they were willing to participate in the interview and be recorded on audio. Finally, eight students completed the interview. The average experience points of the eight students was 421.875 in comparison with the class mean of 366.15. Seven of the interviewees reached the highest level of the promotion track and ranked from first to seventh in the final leaderboard. One interviewee reached the second highest level of the promotion track with a rank of 12 on the final leaderboard.

Five students chose the face-to-face interview and finished the interview in the week following the end of the course. One student chose the online interview on the eighth day after the course ended. However, due to a technology issue, the interview was conducted face-to-face in the department's project room where the other five students finished the interviews. Two students chose to email back their response to the interview question due to their busy work schedule. One student emailed the response back 24 days after the course ended. The other student sent back his audio response transcript (by using Otter) on March 26, 2019.

The six face-to-face interviews lasted from 24 minutes to 58 minutes with an average of 40.83 minutes. The interviews were recorded by using the Voice Memos app on iPhone and were transcribed verbatim by the researcher in MAXQDA qualitative data analysis software. The written responses were imported to MAXQDA directly. The audio response transcripts were saved as a PDF file first from the Otter website, then using an online OCR tool, the responses were saved as a Word document. After checking with the audio recording on Otter to correct the audio recognition mistakes, the Word document was imported to MAXQDA.

For all the students who finished the interview, a $15 Amazon Gift card was sent to them as compensation for their time.

Content Analysis

Unit of analysis. For the coding of the interaction quality, rather than using one message as the unit of analysis, the study used one response as the unit. For example, Student A replied to two messages from peers in one message, so this message contained two responses. Student A's message to one peer included two unrelated topics, so this message was also considered as containing two responses.

Coding process. When applying IAM (Gunawardena et al, 1997), we used the 21 sub phases as our codes. A second coder joined the coding process, who first learned the coding scheme, then read the coding examples from data of the study. As the first coder, I coded all the discussion threads. The second coder coded 30% of the discussion threads, which was randomly selected from the three courses with two exceptions, explained below. The interrater reliability was calculated by MAXQDA.

The interrater reliability was 0.57 for the prototype gamification course, which was coded first in May of 2018. By multiple discussions, the two coders reached agreements and made adjustments in the coding criteria based on the context of the course.

In June of 2018, the coders finished coding the non-gamification course discussion forum transcripts; the interrater reliability was 0.63. The two coders discussed the differences and reached agreement.

The coding of the revised gamification course discussion forum transcripts took place during and after the course. The discussion forum transcripts of the first two weeks were coded during the course in order to conduct the micro analysis in the second design iteration. The two discussion threads coded by the second coder were purposefully selected to contain the most complex reply-comment structure in each week's threads of the first two weeks. The interrater reliability was 0.66 and 0.57, respectively. The remaining 4 weeks discussion forum transcripts were coded after the end of the course in August and September of 2018; the interrater reliability was 0.63. The two coders discussed disagreement and reached agreement.

Reorganization of the IAM phase. The coding results were used when analyzing the effectiveness of the prototype gamification design in the first design iteration, the immediate effect of RGC in the micro analysis of the second design iteration, and the final retrospective analysis. When conducting the first two analyses, the dependent variables were the original five phases in the IAM, and the five sub-phases in Phase 1 of IAM, respectively. This was because over 70% of student responses were categorized into Phase 1, making the IAM less sensitive to measure the interaction quality in the course. In order to have a comprehensive analysis, in the retrospective analysis, the 21 sub-phases were recategorized into four types. Phase 2 to 5 were combined as Building-on response type. Phase 1 was divided into three types. The direct response to the discussion questions was the Initial response type. The statement of agreement from one or more other participants was the Paraphrase response type. The other three sub-phases were combined as New-info response types, including adding new examples to a statement, and asking and answering questions related to a statement.

Lag Sequential Analysis

Lag Sequential Analysis (LSA) is used to explore the class-level interaction in online discussion forums. The sequential analysis was used to study the characteristics of behavior sequences in psychology (Bakeman & Gottman, 1997). The LSA focused on the patterns of two-event chains in a giving context. In the study, an event is a response. The transitional probability is the probability, given a type A response, of the type B response occurring immediately after. By using sequential analysis, researchers (Hou & Wu, 2011; Wu, Chen, & Hou, 2015) present the actual sequence of the different type of responses in the discussion forums. For example, in Wu et al. (2015), students participated in a project-based discussion activity. For groups who used both synchronous and asynchronous discussion methods, the discussions sometimes looped in the same phase, and sometimes a linear sequence of the first three phases of IAM was presented. However, for groups who mainly used synchronous discussion, the discussion either looped in Phase 1 or was off-topic. Therefore, LSA is an appropriate technique to analyze the class-level interaction pattern and uncover whether there were knowledge building response chains in the discussion forums.

There are a few steps when conducting LSA, and the study followed the suggestion of Bakeman and Gottman (1997). First, a contingency table was created by using SPSS with the rows representing lag 0 response, and column representing lag 1 response by definition, occurring immediately after lag 0 response. The number in each cell was the transitional frequency from the response in lag 0 to response in lag 1. Second, the transitional probability was calculated, which is the transitional frequency for the cell divided by the frequency for that row. Next, to identify which transitional probabilities were significantly different from the expected value, the adjusted residual (z score) for each two-response chains were calculated following the equation in Bakeman and Gottman (1997). As suggested in other studies that used LSA in an online discussion context (Zhang et al., 2017), the z score that was greater than +1.96 indicated a the two-response chain reached the significant level ($p < 0.05$). Finally, the significant two-response chains were used to create the transitional diagram.

LSA was used in both semester and weekly scales to obtain the overall class-level interaction pattern in each version of the course, and how the pattern changed over the weeks.

Social Network Analysis

The students' interaction data were imported to Gephi 0.9.2 to calculate the SNA measures for each week and for the semester, including the local in- and out-degree, directed and undirected links. The in- and out-degree measures from Gephi were the counts of the connected peer. Therefore, Freeman's percentage measure (1979) was calculated in the Excel file—the counts were divided by the group size.

Density was calculated as the actual number of links (directed and undirected from Gephi) of two students present in the network, divided by the maximum possible links in the network (Prell, 2012).

Centralization scores for each week and the semester were also calculated in the excel file by using the degree measures via the following equation (Freeman, 1979, p. 229):

$$C_D = \frac{\sum_{i=1}^{n}[C_D(p^*) - C_D(p_i)]}{max \sum_{i=1}^{n}[C_D(p^*) - C_D(p_i)]}$$

In the equation, the numerator was the sum of the differences of the largest degree of a student to the other students. The denominator was the maximum sum of differences in a network of n student.

The reciprocity score was calculated R environment by using the reciprocity function in igraph package. The reciprocity score was calculated in the unit of a thread, which was different from the weekly degree measures, and density and centralization scores that used the unit of a discussion forum (including multiple threads created in the week). The reason for using a thread instead of a forum as the unit for the reciprocity score was because it aligned with the conceptualization of a complete interaction loop (Yacci, 2000) in the online discussion—a student received a reply after sending out a comment. However, as the degree measures and the density and centralization measures were used to describe the students' connections in the week, it was more meaningful to use the forum as the unit.

Quantitative Data Analysis

A number of quantitative data analysis were used in this study to compare students' interaction in the discussion forums.

The message quantity, in-degree, and out-degree weekly and semester data were imported to SPSS for the following quantitative data analysis. Descriptive data analysis was first conducted to explore the feature of each data set. Since the semester data sets for the three measures did not satisfy the normality assumption, nonparametric analysis was used to compare the differences, including the Kruskal-Wallis test and Mann-Whitney test.

Multiple Regression. The weekly data for the three data sets were first transformed from wide format to long format in order to perform multiple regression in SPSS. The course versions were coded as dummy variables (as in Table 6). Since the final design product was the revised gamification design, the revised gamification version of the course was used as the reference group. Weeks were coded from one to six. After controlling the number of threads created in each week, and the students' facilitator status, it first tested the influences of the course version and the week on the weekly data. Then, the interaction items of the course version and the week were added to the model to detect whether the weekly changing patterns were different under the influence of each version of the course.

Table 6 *Dummy Code for the Three Versions of the Course*

	Original	Prototype
Non-Gamification Course	1	0
Prototype Gamification Design	0	1
Revised Gamification Design	0	0

Furthermore, for the message quantity model, the interaction items for the course version and the facilitator status were added to the model to examine the influences of the facilitator bonus experience points in the gamification version of the course.

One-way repeated measure ANOVA. Since the multiple regression results showed no significant linear relationship between week and the messages posted each week, a one-way ANOVA was conducted to examine a week's influences on the weekly message sum for each semester separately.

MANOVA. In order to compare the interaction quality in the three semesters, in addition to the LSA, MANOVA was conducted to find whether there were statistically significant differences of a linear combination of the percentages of the four response types between the three versions of the course. The dependent variables were the percentages of the four response types of each student because the number of threads were different in each version of the course and had influence on message quantity. Percentages presented the preferences of each type response that students posted.

Discriminant Analysis. The significant results of the MANOVA led to a discriminant analysis to figure out where the differences came from. Specifically, the purpose was to examine the contribution of each type of response to differentiate the three versions of the course.

Phenomenological Analysis

The semi-structured interview was conducted at the end of the second iteration to collect students' experiences and perspectives of the revised gamification course. Specifically, the semi-structured interview focused on whether the design of gamification satisfied students' needs of competence, autonomy and relatedness. Cilesiz (2011) proposed phenomenology as a method to study experience with technology in the educational field. First, comparing with the studies reporting outcomes from using technology, studying the experiences with technology provides more information about the process of teaching and learning with the involvement of the technology (Cilesiz, 2011). Particularly, in this study, the experience of students in the RGC could shed light on the role of each gamification element in influencing students' interaction in the online course. Second, Cilesiz (2011) summarized that a phenomenological approach is appropriate to unearth the structure of the experience and deepen the understanding of the meaning of experience. In this study, students' experience with each gamification element could uncover the answer to the question of how well the gamification design provided the three basic psychological needs for satisfaction.

Following Cilesiz's suggestion (2011), the potential interviewees were students who completed the revised gamification course so that they all had significant experiences with the revised gamification course. Therefore, the interview invitations were sent to all 13 students in the course. Though one student finished the interview six months later than the end of the course, it was still included in the data set since the major criteria of inclusion was completing the course.

The data analysis procedure followed the steps in Cilesiz's (2011) suggestion of using a phenomenological approach to study participants' experiences with educational technology. First, the transcripts from all the interviewees were imported in a MAXQDA project and were read by the researcher to tease out the relevant experiences. Second, the transcripts were coded into segments according to the gamification element involved. Third, by using the summary function in MAXQDA, the segments were organized as a contingency table with the rows as the gamification elements and the columns as each interviewee. Then, individual textural descriptions were written for each individual's experience of each gamification element. Fourth, by continuing to use the summary table, the individual experiences of the same gamification element were compared to identify the commonalities and variations and the reasons for them. For example, how students interpreted a bonus experience activity and whether the different interpretations led to different narration of their participation in the activity. Finally, I synthesized the common structures of the gamification experience and created a final description of students' experience of the revised gamification course.

Table 7 *Data Analysis Summary*

Data	Analysis
Message quantity	• Descriptive Analysis ○ Number of posts in the discussion forum in total and in each week • Kruskal-Wallis test and Mann-Whitney Test are used to compare the total number of each student's posts in the online discussion forum in the three courses • Multiple Regression is used to compare the weekly participation data in the three courses • One-way Repeated ANOVA is used to examine the weekly changes over the semester in the three versions of the course respectively

Interaction dynamic	• Social Network Analysis
	  ○ In-degree and out-degree of each student in total and in each week
	  ○ Reciprocity
	  ○ Density of the semester and in each week
	• Kruskal-Wallis test and Mann-Whitney Test are used to compare the out-degree of students in the three versions of the course.
	• Multiple Regression is used to compare the weekly in-degree and out-degree in the three versions of the course

Interaction quality	• Content Analysis ○ Coded each response in terms of the 21 sub-Phases in IAM • MANOVA is used to compare proportion of each response type that students posted in the discussion forums • Lag Sequential Analysis is used to describe and compare the class level interaction pattern
Gamification participation	• Descriptive Analysis
Gamification experience	• Phenomenological Analysis

Chapter 4 The Gamification Design Process

The study adopted a design-based research approach in order to investigate a gamification design for online courses and its influences on students' interaction. As shown in Figure 4, the study included two design iterations. The first design iteration started from the analysis and design of the PGC. Then the findings were used to revise the gamification design. The second design iteration started from the redesign of the RGC, followed by a comprehensive analysis of students' interaction in the three years. Conclusions were drawn and presented in the final chapter. After consulting with a design-based research expert, a micro analysis was added to the RGC to examine the effectiveness of the design revisions (personal communication with Dr. Sharpe, February 15, 2018). An ongoing analysis of students' learning activities and the support from the instruction within the micro cycle provides opportunities to test and refine the intervention design (Cobb, Jackson, & Sharpe, 2015). In this study, formative analysis of students' interaction and gamification performance of the first week was conducted. The findings informed the following implementation of the RGC.

This chapter introduces the gamification design product from the two design iterations in the study. It describes each gamification element in the gamified courses including both the prototype and the revised design. Then I present the design process including the design adjustments between the two design iterations and within the second iteration, and why these adjustments were made.

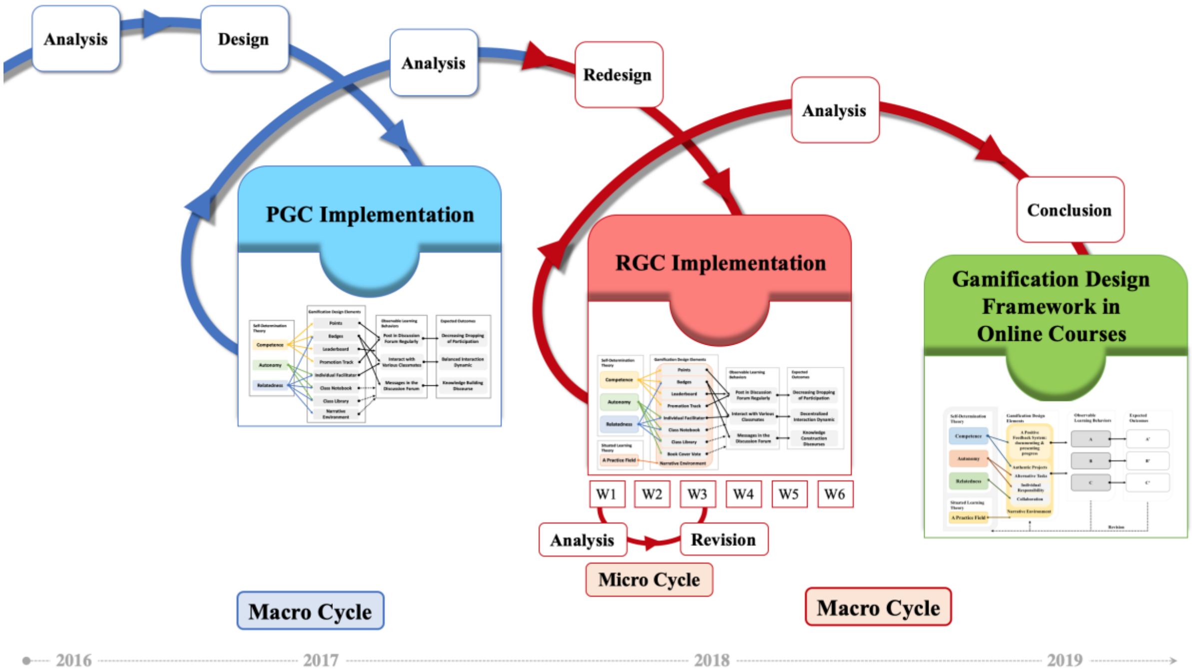

Figure 4 *The Two Macro Design Cycle and the Micro Design Cycle*

The Gamified Course

The gamification versions of the course were implemented in the summer of 2017 and 2018. The NGC, which was implemented in 2016, had two major assignments—an online discussion and a book chapter writing project. The PGC kept the original course design but added a positive feedback system, which was focused on the online discussion in order to improve students' interaction. The RGC, which was implemented in the summer of 2018, kept the course design and the major gamification design elements, but it reconceptualized the narrative environment, improved the deliverables of several gamification activities, and adjusted the implementation plan.

The gamification design in the study included a narrative environment and a positive feedback system. The positive feedback system included experience points, badges, a leaderboard, and a level system, documenting students' efforts in the course. The narrative environment, which originated from the book chapter project, included role assignments, and the developments of the book writing project.

The Narrative Environment

The narrative environment was based on the book chapter project in the NGC. Students in the gamification version of the course were assigned the role of regional specialist and were expected to be trained in this summer camp to write a book together. Therefore, they needed to gain experiences in the process by participating in various camp activities, such as participating and facilitating the online discussion, sharing reading notes, and contributing reading materials to the class library.

In the PGC, the narrative environment was reflected in the email communications. Students received an initial email about the gamification setting on the first day of the course. For all the emails that students received in the course, they were referred to as “specialist” to echo the role assignment.

In the RGC, the narrative environment was emphasized by increasing the authenticity of the book chapter project. During the course, whenever a written assignment was submitted, I created a Google doc that included all students’ work and shared it with the students to show them the progress of creating the book. Additionally, students decided the cover of the book by participating in a voting activity, which started in week 4. The initial email in the RGC was also sent to students three days ahead of the first day of the course to give students time to get familiar with the gamification settings. The reasons for the changes in the RGC were discussed in the design process section in this chapter.

Experience Points

In the gamification versions of the course, experience points were awarded to students for participation. They reflected students' activity level in the course. The amount of points awarded to each learning related behavior was based on the estimated mental effort needed. In general, there were two major categories: regular experience points and bonus experience points. Table 8 is a summary of the experience points items in the gamification design.

Table 8 *Experience Point Items in details*

Items			Points	Max Points
Regular Experience Points		Choose a country	5	5
		Create a bio thread	10	10
		Build Class Notebook	5/entry	20/week
		Post one original message	5/entry	50/thread
		Post one comment to a peer's message	5/entry	
		Participate the Best Quality Post Poll*	5	5/week
		Build class reading repository	15/reading	30
		Initiate a discussion thread	15/thread	15
Bonus Experience Points	Bio	Post a video introduction of yourself	5	5
	Regular Participation	Participate in a discussion thread three days a week*	5/thread	15/week
	Promotion	Have at least 15 points by the end of the Thursday in the first week	10	10
		Have at least 105 points by the end of the second week	10	10
	Facilitator	The number of messages in a thread is over 45 (facilitator's posts should be under 50%)	50/thread	5

Note: * items are only available in the revised gamification design version of the course

Regular experience points. Regular experience points were a reward for task completion (Ryan & Deci, 2017), which corresponded to the granular competence feedback in the PENS model (Rigby & Ryan, 2011). Regular experience points were given to students when they participated in the course activities, including selecting a country of interest, posting messages in the discussion forum, sharing reading notes in the class notebook, creating and facilitating discussion threads, and contributing to the class library for weekly readings. Except for sharing reading notes, all other activities existed in the NGC.

Posting messages in the discussion forum. One major component in the course was the discussion forums where students discussed critical issues about educational technology in different countries. During the six-week period, there were eight discussion forums in total. One was for students to post general questions about the course. One was for students to post their self-introductions in the beginning of the semesters. The other six discussion forums were all about academic discussion, and open for a particular week starting Monday and ending Sunday. In the first two weeks, it was the course instructor who created three discussion threads for each week. In the last four weeks, all the threads were initiated by the student facilitators in the week. In each forum, there were three to five threads, depending on the number of student facilitators.

Students earned five experience points from posting a message in the academic discussion forum. To protect students from early burn out, there was a points cap for each week. Taking the discussion forum for example, in each week, students could only earn at most 50 experience points by posting in the discussion forum. Usually there were three to five discussion threads in each week. Ten messages meant that students could have several conversation turns with peers in the discussion forum. Students could post as many messages as they could in each week; however, they would not earn experience points for the messages beyond the first ten.

Creating a self-introduction thread earned students ten experience points, but replying in the self-introduction threads did not earn students any experience points. Posting questions in the general question forum did not earn students any experience points either.

Individual facilitator. In the last four weeks, each student had the opportunity to contribute to the class library for weekly readings and create and facilitate a discussion thread individually.

Contributing to the Class Library for weekly readings. When students were the facilitator of the week, they had the responsibility to find appropriate readings for the rest of the class to learn the educational technology issues in the country they selected. Selecting one reading material earned the student 15 experience points, and they could earn, at most, 30 experience points. Students were required to send the readings to the course instructor for approval, and the course instructor posted the readings in each week's folder with the contributor's name tagged in the title.

Creating and facilitating discussion threads. The other task for the facilitator was to create and facilitate the discussion forum, which earned them a maximum of 15 experience points. Before students created the discussion thread, they were required to send the discussion questions to the course instructor for approval.

Sharing reading notes in the class notebook. There were assigned readings for students in each week. In order to encourage students to read the materials, experience points were rewarded to students who shared the reading notes in the class notebook. The class notebook was built using the wiki feature in Blackboard. The comments function was closed in order to differentiate it from the discussion forums. In each week, one notebook was open for the entire class from Monday to Sunday. The reading notes could be, but were not limited to, quotations, summaries, comments, and opinions of the materials.

In the PGC, I created a page for each assigned reading each week in advance. Students posted their reading notes for each article in the designated page in the class notebook. In the

RGC, students could create their own personal page to add notes. The reason for the change was discussed in the design process section in this chapter.

Sharing one note could earn students five experience points, and they could earn, at most, 20 experience points each week. Therefore, in each week, students would not earn any more experience after they posted four reading notes. The reason of setting the cap at four reading notes was that in each week, there was at least three article for students to read. Students could share one note for each reading and notes from their own readings for the book chapter writing projects.

Participating in the peer evaluation activity. These regular experience points were added in the RGC. Students who participated in the peer evaluation activity through a Qualtrics Survey would earn five experience points.

Participating in the book cover vote activity. These regular experience points were added in the RGC. Students who voted for the book cover via the Qualtrics Survey would earn five experience points.

Bonus experience points. Different from regular experience points, which were rewarded to students for task completion, bonus experience points were rewards for performance that required extra efforts (Ryan & Deci, 2017). There were four types of bonus experience points in the course. Except the video self-introduction bonus, which corresponded to the granular competence feedback, the other three types of the bonus experience points corresponded to the sustained competence feedback, which required students to maintain an active participation level (Rigby & Ryan, 2011).

Video self-introduction bonus. Posting a self-introduction video could earn students an extra five experience points.

Facilitator bonus. Facilitator bonus was award to student facilitators when the total number of the messages in the thread they facilitated reached 45 and the facilitator's postings were less than 50%. The number 45 was chosen based on the total number of students in the class at the beginning with the expectation that an exceptional facilitator should have a two-turn conversation with the classmates in the discussion thread. The two-turn conversation meant the facilitator made a comment to the classmates' responses to the discussion questions, and the classmates made a response to the facilitator's comment.

Promotion Bonus. Promotion bonuses were rewarded to students if they reached certain levels in the expected dates. The reason for a promotion bonus was to encourage students to finish certain activities on schedule. For example, students should post the self-intro and select the country in the first week.

Regular Participation Bonus. This bonus was added in the RGC. For students who posted messages in a discussion thread for three days in a week, they would be rewarded five experience points per thread. In one week, one student would not win more than 15 experience points. The reason for adding this bonus reward was discussed in the design process section.

Badge

Different from the experience points, which were a reward to students for task completion, the badges set higher performance goals for students. Only a few of students who performed best in certain tasks could win them. The gamification design included two major types of badges, one was for the written assignment, and the other was for the discussion forums.

Badges for the written assignment. Besides the final book chapter, there were two other written assignments contributing to the final book chapter. For each assignment, the highest score owners won the badge.

Badges for the discussion forums. There were three badges as weekly awards for extraordinary performance in the discussion forum—one was regarding the quality of the messages and the other two badges were regarding the broadness of interaction. Facilitators of the week were excluded from the three badges.

The best speech badge. The best speech badge was an award for the peer-evaluated best message in each discussion thread. In the PGC, the peer evaluation system was a rating feature embedded in the Blackboard discussion forum that enabled students to rate each message by lighting up the stars on the upper right corner of the message interface. In the RGC, the peer evaluation activity was delivered through a Qualtrics survey. The link to the survey was sent to students each Friday, valid until 10 pm Sunday night. The survey included two questions: who they felt they have learned from in the week, and which message they want to nominate as the best message in this week. The reason for the changes is discussed in the next section: the design process.

The resourceful badge. The resourceful badge was an award for students who actively responded to various classmates in each thread. When deciding the winner of this badge, both the number of comments (quantity) and the broadness of interaction with peers (local out-degree measure from SNA) were taken into consideration. In each week, the out-degree of each student in each thread was calculated first, then the value of the out-degree and the number of the messages posted in total was added together. The student who had the largest sums won the badge.

The incentive/inspiring badge. The incentive/inspiring badge was an award for students who received replies from the most classmates. When deciding the winner of this badge, both the number of comments (quantity) that the student received and the variety of the repliers (local in-degree measure from SNA) were taken into consideration. The in-degree of each student in each thread was calculated first, then the value of the in-degree and the number of messages received were added together. The students who had the highest sum won this badge. In the revised gamification design, the name of the badge was changed from “incentive” to “inspiring” to make it more aligned with its meaning.

Leaderboard

The leaderboard presented accumulated experience points and the badges for each student using the country name that the student selected. The leaderboard was updated on Monday and Thursday each week. Besides the leaderboard, each student could also access their own experience points and badge records in a designated web page where they could only see their own data. For each time the leaderboard and the personal points sections were updated, students received an email notification, which also included a brief summary of students’ performance in the past few days; for example, whether there were students who won more than one badge or students who were promoted.

The Level System: a Promotion Track

The experience points decided students’ titles in the promotion track. As students earned more and more points, they were promoted to higher levels, from interns to senior regional specialists. The final rank decided students’ final participation points in the course. The level system corresponded to the cumulative competence feedback in the PENS model (Rigby & Ryan, 2011). Table 9 is a summary of the level system.

Table 9 *The Promotion Track in the Gamification Design*

Title	Experience Points Needed	Course Grade
Regional Specialist Candidate	0 - 15	10
Regional Specialist Intern	16 - 95	20

Junior Regional Specialist	96 - 310	30
Senior Regional Specialist	311 and above	40

The points for each level and the date of winning the promotion bonus were based on the minimum requirement from the NGC. All the students started from zero experience points and the lowest level as a candidate for the regional specialist. On the first Thursday, students were supposed to have posted a self-introduction and selected a country. Finishing both tasks would win students 15 experience points and level them up to the next level: an intern. The minimum requirement in the original course was to post one original message and a comment message in each discussion thread. In the gamified courses, if students reached this requirement, they should win at least 30 points for posting in the discussion forum in each week. Moreover, there were three readings in the first week and one reading in the second week; students were expected to post four notes for the first two weeks. Therefore, by the end of week 2, students were expected to earn 95 points and to be leveled up to the junior regional specialist level. The next leveling up point was set at the end of week 5. At this time, the majority of the students should have been individual facilitators (which could earn them up to 45 experience points). I expected them to win 310 points and be promoted to the senior regional specialist. The gap between each level was smaller at the beginning in order to help students build confidence. Then the gap became larger in order to maintain the leveling up as a challenging task.

Students had the information of experience points needed for each activity and for each level; however, they did not know the calculation described above. This was designed on purpose to provide students optimal choices of their participation in the course. From the students' point of view, they needed to plan which activities they should participate in to reach the next level.

The Macro Cycle: from the Prototype Gamification to the Revised Gamification

Following the description of each gamification design element in both versions, this section focuses on the findings of students' interaction and gamification participation, and the rationale for the adjustments between the two macro cycles.

Findings from the Prototype Gamification Design Cycle

The PGC was designed and implemented in 2017. After the course ended, the data were collected, cleaned and compared with the non-gamification version of the course in 2016. The findings shared in this section are a summary of students' participation in the gamification activities, and their interaction in the discussion forums in comparison with those of the group in 2016.

Students' participation in the Prototype Gamification Course. The final average experience points was 253.46 (*SD* = 93.439) with a median of 285. In total, five students were promoted to the senior regional specialists, and the other eight students reached the junior regional specialist level.

The majority of experience points came from posting in the discussion forums. Overall, the 13 students posted 557 messages in the 21 academic discussion threads in the six weeks. Each student posted about 7.14 messages each week. From week 2 to week 5, there were always students who posted more than 10 messages a week (beyond the cap students could earn in one week).

All 13 students participated in the individual facilitator activity. One student created two discussion threads while the other 12 students created one thread per person. All the students participated in the class library activity, which required them to share one to two articles about the country they selected in the week when they were the student facilitators. Five out of 13 students shared one reading article, and the others shared two articles per person.

In total, six students participated in the notebook activity. During the six weeks, fewer and fewer students shared their notes in the class notebook. In the last week, none of students shared any reading notes in the class notebook. Students who shared their reading notes frequently in the class notebook also performed actively in the discussion forums.

None of students posted a self-introduction video; all 13 students chose to write a text version of the self-introduction. Therefore, none of the students won the self-introduction video bonus points. For the facilitator bonus, only one student's thread received more than 45 responses and eventually won the 50 bonus experience points. The coverage of the promotion bonus was wider compared to the other two types of bonuses. Seven students won the intern promotion bonus and five students won the junior specialist promotion bonus.

For the three badges designed for the discussion forum, 20 in-degree badges (the incentive badges) were issued to nine students, and 18 out-degree badges (the resourceful badges) were issued to six students. Four peer evaluation badges (the best speech) were issued to four students in the third and fifth week only. Few students participated in the peer-evaluation activity via the rating system embedded in the Blackboard forum. 11 out of 13 students won at least one badge. The highest number of badges won by one student was 11.

Due to a technical issue, the leaderboard and personal points page clicking data of the third week's updates and the fourth week's first update were lost. Based on the rest of the data, there existed a variation of the click frequency among students. Some students checked these two sections more than once on the update day, and there were two students who never checked the leaderboard on the update days.

Discussion of the gamification performance. The PGC included a positive feedback system documenting students' progress in the online course. For each activity that could earn students experience points, I set a point cap to keep students from early burn out. Some students did more work than the point cap of each activity, while others did less work, some not even reaching the minimum requirement in the NGC. The gamification performance data revealed that students were not motivated by the gamification design equally. It is reasonable to doubt whether students were fully aware of the gamification settings and rules in the study. As in Kyewski and Krämer (2018), only a portion of students realized the badges in the course, which influenced their knowledge and perception of the gamification design. In the first iteration of the study, the gamification description was shared with students through a Google Site. The link to the website was put in the syllabus and was also sent to students in the notification emails. Since the Google Site did not provide any documentation of its visiting data, there was no way to know how many students opened the site. The leaderboard and the personal page were located on the Blackboard course site. The partial click data from Blackboard potentially presented students' various levels of interests in the gamification design. This might be one of the reasons that caused the course performance variations.

The comparison of students' interaction in the PGC and NGC. This section highlights the major findings in the first design iteration in order to discuss the adjustments between the two cycles. The comprehensive comparison of students' interaction among the three versions of the course was conducted after the end of the second iteration, and is presented in the next chapter, including the statistical models, tables, and figures.

More messages were posted in the PGC. Overall, 23 students in the NGC posted 675 messages, and 13 students in the PGC posted 557 messages in the academic discussion forums (excluding the self-introduction threads and general question threads). The multiple regression showed that after controlling the number of threads in each week and student facilitator status in each week, students in the PGC posted 1.44 more messages than students in the NGC ($B = 1.443$, $p = .047$) in each week. However, week as an independent variable did not present a linear effect on students' participation pattern ($B = -.066$, $p = .475$).

The student facilitators in the PGC were more active. The interaction item of the facilitator status and the gamification condition showed a positive influence on the number of messages posted in each week ($B = 6.573$, $p < 0.001$). This indicated that the gamification condition's effect on message posting was moderated by student facilitator status. Particularly, the PGC student facilitators posted more frequently than the NGC student facilitators. However, non-facilitator students posted a similar number of messages in the two semesters. One reason for the PGC student facilitators' active participation might be due to the bonus experience points. The PGC student facilitators more actively replied to the peers who participated in their threads in order to further the discussions and to eventually win the bonus points.

The variation of the messages posting patterns was larger in the PGC. In the NGC, there was a significant difference between the messages posted per thread in each week (F (5,110) = 2.855, $p = .018$). Partial eta square was 0.115, which was a medium effect according to Cohen (1988). In the PGC, though differences between messages posted per thread in each week were not significant (F (2.335, 28.025) = 2.916, $p = .195$) (Mauchly's test was violated, therefore I reported the corrected F value based on Greehouse-Geisser). Partial eta square was 0.195, which was a large effect according to Cohen (1988).

Given the two effect sizes, the influence of week on students' message posting was larger in the PGC. Particularly, students in the PGC posted fewer messages in the discussion forum in week 1 and week 6. The pairwise comparison in the one-way repeated-measures ANOVA showed significant differences between week 1 and week 2 (p = 0.007), and week 1 and week 3 (p = 0.026). One possible reason was that in the prototype gamification course, students were still getting familiar with gamification rules in the first week.

The students' interaction was more evenly distributed in the PGC. After controlling the number of threads and the facilitator status, there were no statistically significant differences in the weekly in-degree (the proportion of peers who sent messages to a student) and out-degree (the proportion of peers who a student sent messages to) measures between the two versions of the course. But week as an independent variable presented a positive effect on both measures (in out-degree model: B = .033, p< .001; in the in-degree model: B = .019, p = .020).

When comparing semester in-degree values, the Mann-Whitney Test showed a significant difference (U = 76, p = .015) between the two versions of the course. In the PGC, the comments students received were from more classmates compared to students in the NGC in the semester scale. The PGC students responded to more peers over the six weeks than the NGC students; however, the difference was not statistically significant (U = 96.5, p = .077). The different results of the semester in-degree and out-degree comparison meant that even though students sent messages to a similar proportion of classmates in the two courses, the receivers of these comments were more centralized in the NGC. In other words, most students in NGC sent messages to only a few certain classmates over the semester, while most students in PGC sent messages to different classmates over the semester.

Ratio of mutual dyads in each thread. A mutual dyad was a complete message loop in a discussion thread—a student sent out a message to another student and received a reply. In the NGC, the mean dyad ratio was 0.29 (SD = .21, N = 36). In the PGC, the mean dyad ratio was

0.40 (*SD* = .22, *N* = 20). Mann-Whitney Test results showed that the difference was not significant (*U* = 253.50, *p* = .068).

Density and centralization scores comparison. The PGC had a higher density score (= .885) than the NGC (= .763), with a lower centralization score (0.06 of the PGC, 0.11 of the NGC) on the semester scale. This result indicated that more links between students existed in PGC, and the distribution of the links was more even than the NGC.

More content-focused messages and building-on behaviors in the gamified class. The messages that students posted in the discussion forum were coded using the IAM (Gunawardena et al., 1997). In the PGC, students posted significantly more content-focused messages, *Chi-square* (5, *N* = 1241) = 16.23, *p* = .006. As shown in Table 10, the majority of the messages were in Phase 1 in both courses.

Table 10 *IAM Phases Distribution in the Two Versions of the Course*

	Phase 1*	Phase 2	Phase 3	Phase 4	Phase 5	Non-Academic
PGC	428	92	43	2	11	8
	73.29%	15.75%	7.36%	0.34%	1.88%	1.37%
NGC	468	89	49	5	11	35
	71.23%	13.55%	7.46%	0.76%	1.67%	5.33%

* Phase 1: Sharing/comparing of information; Phase 2: The discovery and exploration of dissonance or inconsistency among ideas, concepts or statements; Phase 3: Negotiation of meaning/construction of knowledge; Phase 4: Testing and modification of proposed synthesis or co-construction; Phase 5: Agreement statement(s)/applications of newly constructed meaning.

Table 11 shows the IAM Phase 1 subcategories distribution, *Chi-square* (4, *N* = 896) = 28.65, *p* < .001. In summary, the PGC students preferred adding examples (1C) and asking further questions (1D). They also posted less non-academic messages and less paraphrase messages.

Table 11 *IAM Phase 1 Sub-category Code Distribution in the Two Versions of the Course*

	1A (Initial response)	1B (Paraphrase response)	1C (Example response)	1D (Q&A response)	1E (Problem response)
	200	64	69	83	12
PGC	46.73%	14.95%	16.12%	19.39%	2.80%
	257	98	57	55	1
NGC	54.91%	20.94%	12.18%	11.75%	0.21%

The chances that PGC discussion remained and returned to Phase 1 was high. LSA was performed for the academic discussions in the two versions of the course to explore how the discussion developed in terms of IAM Phases by illustrating the overall reply structure among messages in each Phase (Figure 5).

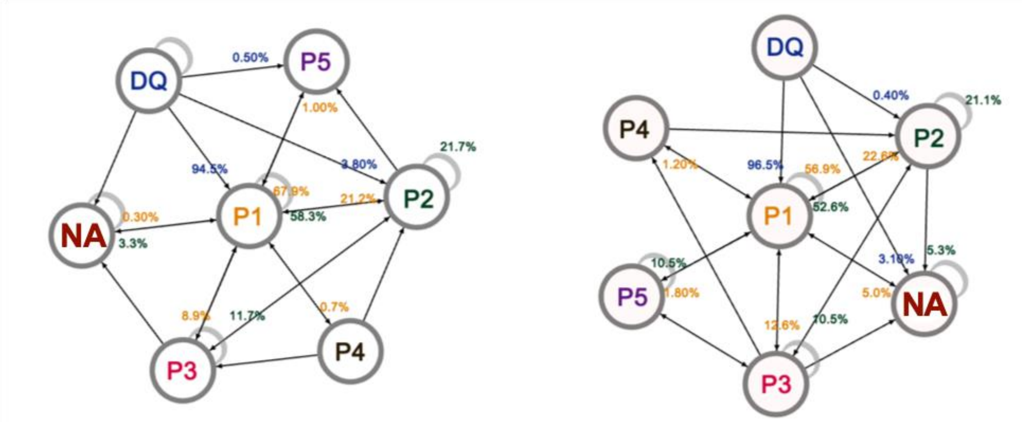

Figure 5 *LSA Phase Transitional Diagrams, the diagram on the left is in PGC, the diagram on the left is the NGC. DQ = Discussion questions, NA = Non-relevant messages. The transitional probability was in the same color as the starter message (lag 0) in this two-response chain. For example, the probability of Phase 1 type messages occurring after Phase 2 type messages was 58.3% in the PGC, 52.5% in the NGC. Due to the space limit, not all transitional probability was labeled in the figure.*

In the PGC, the probability of the Phase 1 messages occurring after Phase 1 message (Phase 1 loop) was 67.9 %, and the number in the NGC was 56.9%. This pair of numbers indicated a higher chance that discussions remained in Phase 1 in PGC. Thus, even though students in the PGC posted more “Example,” “Q&A,” and “Problems” messages, these messages did not lead to further development of the discussion in terms of IAM. Two examples of the Phase 1 loop from the NGC and the PGC are presented below. In the NGC example, Student 22 posted an initial response to the discussion question. Then, Student 27 stated agreement with a reason. The two responses positioned at level 1 and level 2 in the discussion thread.

Student 22:

Personally, I do not think ICT can completely solve the inequality within education. However, I do think it can dramatically assist it if is made accessible to those in rural areas. The use of ICT makes learning and instruction more convenient because of its accessibility so I believe that if citizens in rural areas were provided with Internet access great strides would be made towards closing the inequality gap. [Code at 1A: A statement of observation or opinion]

Student 27:

I agree. We can't solve all problems by metal, electricity, and bandwidth connection that can be supplied with educational materials. However, if introduced wisely, there will be tremendous changes [Code at 1C: Corroborating examples provided by one or more participants]

The responses in the PGC example positioned at level 2 to level 3. Student 6 shared a quote to express her agreement with Student 8 (who posted an initial response to the discussion question). Then, Student 9 commented on Student 6’s message by showing agreement.

Student 6:

Student 8,

I also like this analogy for describing technology integration into classrooms or curriculum. We don't actually want technology. We want an educated populace. When you go to the hardware store to buy a drill, you don’t actually want a drill, you want a hole, they don’t sell holes at the hardware store, but they do sell drills, which are the technology used to make holes. We must not lose sight that technology for the most part is a tool and it should be used in applications which address educational concerns. (Fletcher, 2006, p. 87)

As you point out in the Wikipedia example and Student 9 mentioned in his teaching videos example, the choices designers, instructors, and content experts make are not neutral. The same happens with the choices of technology. Technology is a separate entity from pedagogy and learning. The machine or tool does not create the result. However, there are many influences on what instructors select and use. Software developers, researchers, web developers, and even marketing representatives influence these choices.

Source

Fletcher, G. (1996). Former director of the Division of Educational Technology, Texas Education Agency, Executive Vice President of T.H.E. Institute quoted in T.H.E. Journal, 24(4), p. 87. [Code at 1C: Corroborating examples provided by one or more participants]

Student 9:

Wow! What a great quote!

I've got nothing to add here. That quote gives so much to think about.

Thanks for sharing!

Student 9 [Code at 1B: A statement of agreement from one or more other participants]

Additionally, the majority of responses to Phase 2 messages was still Phase 1 messages in both courses. In the PGC, the percentage was 58.3% compared to 52.6% in NGC, indicating more than half of the argument in the messages had not been further advanced. Such results showed that there was still a higher chance of the discussion between students returning to Phase 1 in PGC.

Below are examples of Phase 2 -> Phase 1 response chain from the two courses. In the PGC example, Student 2 responded to Student 3’s follow-up question and furthered her initial statement by adding the idea of the “bottom up plan.” Then, Student 3 presented her agreement to Student 2’s statement. This is a common example that students used an agreement statement to close a discussion.

Student 2:

Hi Student 6,

I'm not sure I have an answer about how we could change to allow for a common goal as far as ICT goes on a national level in the US. As I mentioned before, having everyone (government, private sector, institutions and citizens) on the same page in the US is incredibly difficult given our culture is highly individualistic (and with the current political climate). I think maybe working toward a common "ICT goal" might work better if these common goals were first formed at the state or county levels, then these goals could better address the needs, values, and divides in each community. I think if these common goals help to produce successful ICT programs other areas of the country might follow successful examples. This would be a very long range bottom up plan. I believe that there also needs to be strong leadership at these local levels that has a longterm goal and is willing to include others in that process. [code at 2C: Restating the participant's position, and possibly advancing arguments]

Student 3:

Student 2,

I like your thoughts on this. Passion and change that originate from inside a group, community or municipality can carry so much power and influence! [code at 1B: A statement of agreement from one or more other participants]

In the NGC example, Student 36's response expanded Student 37's point by mentioning the example of the learning community concept. Student 34 then presented his agreement.

Student 36:

I really enjoyed this reading in terms of how he explained a school as being an learning community. too many times teachers have a much larger load then the students which make sense is in "schools" for young students. however i agree with the concepts of learning community for students in teachers that have more experience with each other. I agree with Student 37 that teachers often have trouble with the training aspect of new education technologies. for my country in studying nigeira, i feel the concepts of a learning community will emphasis the point of teachers learning from students so they can continue to teach and improve the learning community [Code at 2C: Restating the participant's position, and possibly advancing arguments]

Student 34:

So you mean that teachers should have a deeply understanding of students, that teachers can teach and communicate with students more properly in school. Yeah I agree with that, we should emphasise the importance of this issue. [Code at 1B: A statement of agreement from one or more other participants]

In summary, first, there were more messages posted in each week in the PGC. The proportion of peers that a student interacted with in each week was almost the same in the two courses. Therefore, in PGC there were more turns of information exchanges between two students. The higher ratio of mutual dyads in the PGC agreed with this postulation. Moreover, over the 6-week period, students in the PGC received replies from a wider range of peers. Given similar numbers of commenters that a student had in a week in both two courses, this semester difference indicated that students in the PGC received replies from different classmates among weeks; however, the replies to the NGC students were created by similar classmates in each week. The density scores and the centralization scores were consistent with this explanation, indicating a more evenly distributed interaction in the PGC. Finally, students in the PGC posted more "Q&A" and "Problems" responses in the discussion forum. Results from LSA showed the discussion in both courses tended to stay at the same or lower phases in terms of IAM, as much previous literature suggested (Lucas et al., 2014). These findings displayed that the gamification design did have a positive impact on students' interaction, but they also revealed some performance issues that were related to the gamification design.

The Design Success, Issues and Theoretical Reflection of the PGC

Based on the findings from students' gamification performance data and students' interaction comparison results, there were both successes and issues of the PGC.

The positive influences of the positive feedback system on students' interaction. In the PGC, experience points were designed to reward students' efforts in the various course activities, which also decided students' levels and the participation score in the final grade of the course. The experience points were updated twice a week and praised students' efforts in a short time period. This design maintained students' participation in the discussion forums in the PGC. According to the multiple regression results, students in the PGC posted significantly more frequently than students in the NGC on a weekly basis. Additionally, the higher value of the bonus experience points on discussion facilitation represented the challenging nature of the task, and encouraged the PGC student facilitators to actively interact with other students.

Badges were used in the PGC to encourage students to achieve extraordinary goals in the course. Different from experience points, which could be obtained by task completion, badges were only awarded to the top performers. Therefore, winning badges represented achieving the challenging tasks in the course. One of the five badges was to encourage students to comment on the posts of various peers, and the other one was designed to encourage students to write original messages to attract more comments. Even though in each week the number of peers that students interacted with was similar in the two semesters, over the entire course period, PGC students received comments from a wider range of classmates, and the distribution of student interaction was more even in the PGC than the NGC. Therefore, these two badges brought positive influences in the discussion forums.

The dysfunctional peer evaluation activity. One badge was designed to encourage students to write high quality content that was valued by peers. However, the best speech badges were only issued in two weeks to four students. Since the badge was decided by the peer evaluation results, this result indicated a low participation rate in the peer evaluation activity, which was delivered through a rating feature embedded in Blackboard's discussion forum. Through a private conversation with a student after the course, a concern of rating a peer's messages in public (though the rating was anonymous) was raised, even though the student recognized the value of peer evaluation.

The peer evaluation badge was designed to encourage students to post quality messages. The comparison of the interaction quality showed that the PGC students posted more “example” and “Q&A” messages. The phase transition patterns comparison displayed that there were knowledge-building message chains in both courses; however, the messages were more likely to remain in or return to the lower phases. Therefore, the deliverable of the peer evaluation activity failed its implementation, and the effectiveness of the quality badge was in doubt.

The challenge of learning gamification settings. The gamification setting was written in a separate Google Site, and the link to the site was added in the syllabus and was sent to students on the first day of the course. Therefore, it did not leave students enough time to learn the gamification settings and rules in the course. This might have influenced students’ participation in the gamification activities. For example, the bonus points on video self-introduction and promotion and experience points on the class notebook were earned only by a few students. The experience points for discussion forums were more straightforward to students, while the other bonus experience points’ rules were rather complicated or new to students. Rigby and Ryan (2011) argued that the intuitive control of a game could influence players’ competence needs. Gamification was not natural knowledge to everyone. Thus, providing students enough time to learn the gamification settings should be taken into consideration.

The theoretical reflection of the narrative environment as a separate gamification element. Compared to the stable pattern of message posting in the NGC, the sharp drop of participation in the sixth week in the PGC could be due to students shifting their focus from participating in the discussion forum to the book chapter project (which was due on the last day of the course). Moreover, as argued in Looyestyn et al. (2017), gamification as a novelty experience attracted students' attention and resulted in higher participation in shorter terms. If the course was longer, the results might not be as good as the six-week course. These two problems were beyond the revision of the deliverables, but are a call to reflect on the design framework and its theoretical foundation.

One weakness of the previous gamification studies was the ambiguous role of course design (e.g. Fanfarelli & McDaniel, 2017; Kyewski & Krämer, 2018). Gamification as one type of motivation design is intended to improve students' engagement in the learning activities. Therefore, it is important to ensure the activities were meaningful and beneficial to students' learning. After all, the eventual purpose of gamification is about learning. In this study, the original course design included a book chapter project through which students showed mastery, in-depth knowledge of educational technology in their country of interest, and the ability to collect, analyze, and synthesize information. The feedback system in the PGC did not include any reward for this project except the two badges, which had no stake in the final grade. Research showed that only the activities attached to points presented higher participation level of students (Hew et al., 2016). Therefore, in the first several weeks, students' time was taken up by the points attached activities, but when the due date approached, they started to work on the writing project, which made up one third of the final grade. This PBL-gamification design was a replication of the existing school achievement system with a game decoration.

To solve this problem, gamification should not only provide an alternative achievement system, it should also become an approach to innovate the learning experience. Therefore, the revised gamification design framework proposed to use a positive feedback system and contextualize it in a narrative environment in order to turn the course into a practice field. As discussed in the theoretical framework in the second chapter, the practice field should be in the knowledge domain and immerse students in authentic projects. Through the lens of the revised gamification design framework, the NGC already included an authentic project, and the PGC did try to bring a cohesive explanation of the gamification activities by setting the theme and assigning students the role of the regional specialist via the narrative environment. Therefore, when applying the revised gamification design framework in the second design iteration, the focus of the narrative environment was to immerse students in the project.

In conclusion, the PGC did encourage students' participation over the 6-week period. However, based on the gamification performance data and the comparison of students' interaction with the NGC, there were also issues that need to be addressed in the next iteration of gamification design: the peer evaluation activity had a lower participation rate; the design of the narrative environment needs to be reconsidered under the revised gamification design framework; and, finally, the challenges of learning the gamification settings should be taken into consideration.

The Design Adjustments in the Revised Gamification Design

Several design elements were adjusted in the revised gamification design based on the results from the first interaction.

Extra time for learning the gamification settings. First, in the RGC, students were given time to be ready for the gamified course in advance. Since it takes time for students to learn the unfamiliar gamification settings, it might increase students' burden in the first week—they need to complete the academic tasks as well as learn the gamification settings. Therefore, in the RGC, the students received the first email of the course three days before the course started. This initial email attached the course syllabus and explained where students could find the gamification rules on the Blackboard course site. Moreover, the gamification rules section was moved from the Google Site to Blackboard. Therefore, it was easier for students to check the rules and it provided more data for me to understand whether students spent time reading the rules.

A new design of the peer evaluation activity. The peer evaluation activity was moved from the rating system embedded in Blackboard to a Qualtrics survey. The survey collected students' opinions in a private approach that could reduce students' concern of rating peers publicly. Moreover, responding to the survey earned students five experience points, as they made a contribution to the author community. Besides issuing the owners of the best messages best speech badges, the messages were also put under the leaderboard, and sent to students in the Monday email.

Emphasizing the narrative environment. The narrative environment was stressed in the RGC in order to provide a coherent explanation of both course assignments (online discussion and the book chapter) and to change the competition relationship between the two assignments. The narrative environment was not limited to the level system and the two badges for the written assignment, and it was emphasized by increasing the authenticity of the book chapter project. Students' action in the course brought the development of the narrative. New activities were added throughout the 6-week course period to remind students that they were working towards creating a book. For each written assignment that students had submitted, including the initial book chapter proposal and the two written assignments, every students' submission was combined in one Google Doc and shared with students after grading. Such essay collections were to inform students of the progress in writing the book. Moreover, in the beginning of the third week, students received a task of choosing a book cover for the final book. Each student had a chance to give scores to the proposed book cover picture. Finally, the narrative had its own finale. By the end of the semester, the final book with the selected book cover was send to students in a PDF format.

The Micro Cycle in the RGC

In order to examine the effectiveness of the above changes, I compared the first week students' interaction among the three versions of the course. By conducting this micro cycle in the RGC, it allowed me to make further adjustments if the changes did not work as expected. Given the six-week course period, the statistical analysis in the micro cycle should be finished within one week in order to make adjustments in time. The data was collected at the end of the first week and was coded and analyzed in the second week. Minor adjustments were made in the third week.

The Findings from the Micro Cycle

One assumption brought into the RGC was that students were not necessarily familiar with the gamification settings—they needed to learn gamification rules in the first week as well as the content, which resulted in the lower participation rate in the first two weeks. Therefore, in the revised version, students were notified about the gamification and given access to the gamification settings in Blackboard three days before the course started. For this change, indicators included the log data of students' click stream of the gamification rules section, as well as the first two weeks' gamification performance and interaction data. The second assumption was that the more accessible deliverable of the peer evaluation activity should improve students' participation rate. For this change, the indicators should be the participation rate. Last, since the changes in the narrative environment were carried out through the whole semester, it was not included in the micro cycle analysis.

Gamification Performance. Based on the Blackboard log data, eight students visited the course after the notification email was sent to them. Before the course started, the eight students spent 0.23 hours, on average, in the course site. Five of them clicked on the Gamification Settings section in Blackboard. During week 1, there were nine students in total that visited the Gamification Settings section. These log data showed that some students took advantage of the extra time before the course and learned the gamification rules. The course syllabus also included the gamification settings and was sent out to students in the first email. However, it was not known whether students spent time reading it.

The values of the experience points showed students' activity level in the various gamification activities. Table 12 presents the values of the experience points from the two versions of the course in the first week. Students in the RGC earned more experience points on average. They were more actively involved in the gamification activities. Six RGC students posted a video self-introduction, while in the PGC, none of the students posted a video. RGC students posted 7.92 messages on average in the first week, while the PGC students posted 3.62 messages. Eight RGC students shared 17 notes in the class notebook, while four PGC students shared six notes. By the end of week 1, several RGC students had already reached the candidate level on the promotion track. For the leaderboard and the personal page click average, the PGC had higher means. Particularly, there were more students who checked the personal page in the PGC based on the median. Additionally, four RGC students participated in the peer evaluation activity in the first week, while the number in the PGC was zero.

Table 12 *Descriptive statistics of the gamification performance data in the two gamified courses in the first week.*

	PGC		RGC	
	Week 1 Thursday	Week 2 Monday	Week 1 Thursday	Week 2 Monday

Experience Points	Mean	16.54	40.38	25.77	61.92
	SD	12.972	24.364	8.861	26.5
	Median	25	40	25	55
	Min	0	0	15	30
	Max	30	80	40	105
Click on the leaderboard	Mean	1.23	1.92	1	1.462
	SD	2.242	3.752	1	1.5064
	Median	0	1	1	1
	Min	0	0	0	0
	Max	8	14	3	4
Click on the personal points page	Mean	1.46	1.54	0.538	1.385
	SD	2.961	3.256	0.6602	1.8947
	Median	1	1	0	0
	Min	0	0	0	0
	Max	11	12	2	5

Comparing week 1 students' interaction in the three versions of the course. The Kruskal-Wallis Test showed significant differences of the number of messages posted (*Chi-Square* (2, *N* = 49) = 6.628, *p* = .036) and the percentage of peers that a student received comments from (*Chi-Square* (2, *N* = 49) = 8.261, *p* = .016). No significant differences of the percentage of peers that a student sent messages to was found (*Chi-Square* (2, *N* = 49) = 5.302, *p* = .071).

Particularly, the Mann-Whitney Test showed that the RGC students posted significantly more messages than the PGC students (*U* = 46.5, *p* = .049) and NGC students (*U* = 76, *p* = .014) in the first week. The RGC students received comments from a larger percentage of peers than the PGC students (*U* = 47, *p* = .048) and the NGC students (*U* = 69.5, *p* = .06). Finally, the RGC students sent messages to a larger percentage of peers than the NGC students (*U* = 85, *p* = .026).

As shown in Table 13, for the IAM phases, compared to the NGC, there were higher percentages of Phase 1 and Phase 5 messages, and fewer Phase 2 messages in RGC. When compared to the PGC, there were lower percentages of Phase 2 and Phase 3 messages. Some students in the RGC had concluded discussions with peers since there were Phase 5 messages posted in the discussion indicating a summary of the discussed topic. However, it was also noticeable that there were fewer Phase 2 messages in the RGC.

Table 13 *IAM Phases distribution in the first week in the three versions of the course*

	P1	P2	P3	P5	NA
NGC	43.75%	31.25%	6.25%	0.00%	18.75%
PGC	69.57%	21.74%	8.70%	0.00%	0.00%
RGC	69.70%	13.64%	6.06%	4.55%	6.06%

Summary. In the RGC, students were given additional time to get familiar with the gamification settings. Based on the data, more than half of the RGC students visited the gamification section before the course. Overall, the RGC students were more actively engaged in the various gamification activities compared to those in the PGC, while less RGC students checked the personal points page. Students posted more messages and interacted with a higher percentage of peers compared to the NGC. Therefore, offering students extra time to learn the gamification rules might have influences on students' first weeks' participation.

The other design adjustment made in the course was the peer evaluation activity in order to select the winner of the best speech badge. Four students participated in the activity in the first week, which was an improvement compared to the PGC where none of the students participated in the activity in the first week.

Overall, the first week's performance indicated the positive influence of the two design adjustments. However, it also revealed some possible performance problems in the RGC. The participation rate (30.8%) in the peer evaluation activity was low. Moreover, except in Phase 5, the percentages of higher phase messages were lower in the RGC compared to the PGC. Several design adjustments were made in the micro cycle.

The Design Adjustment During the Revised Gamification Iteration

In order to increase the chances of the occurrence of higher phase messages, I added a new bonus experience points for week 3 onward. Students who posted in the discussion three days a week would win bonus experience points. This was because higher phases would more likely show up when the students had multiple turns of conversation (Cheng, Zhang, & Lei, 2019). Additionally, in the time when implementing the RGC, Blackboard added a new feature in the discussion board. Each student could know how many replies they received from the others. Therefore, regularly logging in could make the best use of this new feature. Students could find out the replies to them and make comments or answer questions.

In the first week, more RGC students posted notes in the class notebook than the PGC students. Some RGC students created their own note page instead of using the article page I had created for them. Therefore, in the following 5 weeks, I did not create any pages for students. Students could create as many as pages they wanted to, and post notes in the format they felt comfortable with.

Even though there were more PGC students that participated in the peer evaluation activity, the participation rate was as low as 30.8%. Moreover, in week 3, only two students participated in the peer evaluation. In order to prevent the decreasing pattern, a reminder of the five experience points attached to the peer evaluation activity was added in the Qualtrics email from week 4 on.

Summary of the Design Process

During the design process, students' interaction and gamification performance were used to examine the effectiveness of the gamification design. The design framework was adjusted based on the findings. Particularly, the role of the narrative environment was addressed in the revised gamification design. Its relationship with the other gamification elements was reconsidered; the narrative environment contextualized the gamified achievement system in the course design. Accordingly, some design adjustments were made to realize the new role of the narrative environment. On top of the changes in the gamification design framework, the specific gamification deliverables and the implementation plan were also revised to improve students' participation and gamification experience. However, the second design iteration did not stop when the course ended. A comprehensive analysis of students' interaction, gamification participation and experience were conducted after the end of the course. Finally, a generic gamification design framework was proposed. The in-depth quantitative and qualitative analyses are presented in chapter 5. The final gamification design framework is discussed in chapter 6.

Chapter 5 Students' Interaction, Gamification Participation, and Gamification Experience

In this study, a PENS-based gamification design was created and implemented in a graduate level online course in order to improve students' interaction in the academic discussion forums. The previous chapter introduced the design process in the study and the rationales for the design revisions between and within cycles. This chapter's focus was to answer the research questions regarding the effectiveness of the gamification design on students' interaction, and how it worked or did not work. To answer these questions, I first described and compared students' interaction in the three versions of the course in terms of quantity, interaction dynamic, and interaction quality. Since the RGC was the final design product of this study, students' interaction in the RGC was used as the reference group to be compared with the prototype design, and the pre-gamified course. Then I presented the students' participation data of the various gamification activities in the two gamification versions of the course. These findings displayed students' reactions to the two versions of gamification design, and helped to understand how each gamification element worked in the course. Finally, I compared students' experience and perspectives of each gamification elements respectively. These findings revealed whether the RGC satisfied students' competence, autonomy, and relatedness needs necessary for students to maintain an optimal level of interaction in the academic discussion forums.

Comparing Students' Interaction of the Three Versions of the Course

In this section, I examined students' interaction in the online asynchronous discussion forums in the three versions of the course (NGC, PGC, & RGC) from three aspects, including quantity, interaction dynamic and interaction quality. For each aspect, I first compared the data on a semester scale. Then I analyzed weekly data to examine whether the changing pattern over a semester was different between the three versions of the course.

The Quantity of the Messages Posted in the Discussion Forum

Comparing the semester messages sum of the three versions of the course. In the RGC, 13 students posted 819 messages in the academic discussion forums in total. The 13 PGC students posted 557 messages, and the 23 NGC students posted 657 messages. As Table 14 indicates, the average number of messages posted during the six weeks in the RGC was the highest among the three semesters (*Mean* = 63), while the variation of message numbers in the RGC was also the largest (*SD* = 40.65). Particularly, the top three RGC students posted 47.74% of the total messages in the six weeks. The PGC had the second highest mean among the three versions of the course (*Mean* = 42.85), with a standard deviation of 24.2. The top three PGC students posted 40.93% of the total messages in the course. The lowest average number of messages was in the NGC (*Mean* = 29.35), with a standard deviation of 20.80. The top three students posted 42.77% and 42.27% of the total messages in the two groups of the course, respectively.

Table 14 *Descriptive Statistic of Messages Quantity in the Three Versions of the Course*

Version	Total	Mean	SD	Median	Min	Max	Kurtosis	SE	Skewness	SE
NGC (N=23)	657	29.35	20.80	19	10	77	0.018	0.935	1.092	0.481
PGC (N=13)	557	42.85	24.2	43	9	85	-0.929	1.191	0.438	0.616
RGC (N=13)	819	63	40.65	53	23	142	-0.157	1.191	1.123	0.616

As the data did not satisfy the normality assumption, non-parameter tests were used to examine the differences of the message quantity between the three versions of the courses. The Kruskal-Wallis H Test was used to compare the differences of the overall message quantity in the three versions. The result indicated the existence of a significant difference of the message quantity among the three versions of the course, *Chi-square* $(2, N = 49) = 9.801$, $p = 0.007$, with a mean rank of 18.75 for NGC, 27.88 for PGC, and 33.5 for RGC. Next, the Mann-Whitney test was performed to conduct pair comparisons. The significant difference was only found between the RGC and NGC (U = 60, p = 0.003). The difference between PGC and NGC was very close to the conventional level of significance (U = 91, p = 0.054). Finally, no significant difference was found between the two gamification versions of the course (U = 63.5, p = 0.281). Overall, the results showed that students in the gamification courses posted more messages in the semester than their peers in the non-gamification course.

Comparing the weekly message sum in the three versions of the courses. In this section, I present the weekly posting patterns and further compare the weekly quantity over the six-week course period in the three versions of the course. The analysis results answered how gamification design influenced students' participation in the online discussions over a semester.

Table 15 presents the descriptive statistics of the weekly messages sum in the three versions of the course from week 1 to week 6. Except week 5, the RGC had all the highest means among the three versions. Additionally, the RGC also had the highest median in all six weeks. However, similar to the semester data, the standard deviations were higher in the RGC, indicating a larger variation within the RGC students' performance. In other words, RGC students posted more messages in each week, but the differences among the RGC students were also larger. Next, multiple regression was used to examine whether the differences in the quantity of the weekly messages were significant.

Table 15 *Descriptive Statistics of Weekly Messages Quantity in the Three Versions of the Courses*

Week	Version	Mean	SD	Median	Min	Max	Kurtosis	Skewness
Week 1	NGC (N=23)	3.48	3.953	2	0	12	-0.756	0.814
	PGC (N=13)	3.62	3.28	3	0	8	-1.78	0.387
	RGC (N=13)	7.92	7.365	4	3	28	4.286	2.11
Week 2	NGC (N=23)	5.57	3.369	4	2	13	-0.009	1.015
	PGC (N=13)	6.85	4.432	8	0	13	-1.234	-0.307
	RGC (N=13)	9.54	6.616	8	3	25	1.408	1.397

Week 3	NGC (N=23)	4.3	2.584	4	1	9	-0.664	0.653
	PGC (N=13)	9.92	6.198	8	0	21	-0.799	0.356
	RGC (N=13)	9.46	5.456	10	2	19	-0.866	0.289
Week 4	NGC (N=23)	6.35	5.193	4	0	20	0.748	1.088
	PGC (N=13)	7.08	4.481	6	1	17	0.413	0.722
	RGC (N=13)	14.46	14.466	10	1	45	0.746	1.414
Week 5	NGC (N=23)	4.83	4.239	3	0	16	0.687	1.073
	PGC (N=13)	11.77	12.755	9	1	49	6.37	2.367
	RGC (N=13)	10.92	6.626	11	0	20	-1.158	-0.126
Week 6	NGC (N=23)	4.83	4.559	4	0	19	3.146	1.589
	PGC (N=13)	3.62	2.022	3	0	7	-0.122	0.266
	RGC (N=13)	10.69	7.782	6	4	25	-0.565	1.027

Multiple regression was used to compare the differences in the weekly message sum in the three versions of the course, with controlling the number of threads in each week and students' facilitator status. In the regression model, RGC was used as reference group to be compared with the other two versions of the course. The dummy code for the three versions of the course was presented in Table 6. The multiple regression model was Equation 1.

$$Y_{NoM\_W} = a + B_1*NoT\_W + B_2*FS + B_3*Week + B_4*Original + B_5*Prototype + e \quad (1)$$

The regression model summary is presented in Table 16. The group of variables significantly explained the weekly message sum, $F(5, 288) = 16.681$, $p < 0.001$. The adjusted R square value was .21. This indicated that 21% of the variance in the weekly message sum was explained by the model. The difference of the weekly message sum was statistically significant between the NGC and RGC ($B = -3.596$, $p < 0.01$); specifically, the RGC students posted more messages compared to the NGC students. The RGC students also posted more messages in each week than the PGC students, while the difference was not statistically significant ($B = -1.891$). Overall, students in the gamification versions of the course posted more messages each week. The coefficient of week was negative, indicating students posted fewer messages as weeks went by. However, the linear effect of week on the weekly messages sum was not statistically significant. Furthermore, the interaction items of course versions and week were added in the model, but there was no significant change in R square, $F(2, 286) = 0.533$, $p = 0.587$. Therefore, there was no significant interaction effect of week and the version of the course.

Table 16 *Multiple Regression Analysis Summary Explaining Weekly Message Quantity from Gamification Condition, and Week When Controlling for the Number of Thread in the week, Facilitator Status (N=294)*

	B	SE	Beta	95.0% Confidence Interval for B	
				Lower Bound	Upper Bound
Constant	4.535	1.915		0.766	8.304
Number of threads in the week	1.258	0.423	0.211**	0.425	2.091
Facilitator status	4.763	0.984	0.262***	2.827	6.699
Original	-3.596	1.076	-0.267**	-5.714	-1.477
Prototype	-1.891	1.077	-0.124	-4.01	0.228
Week	-0.200	0.229	-0.051	-0.651	0.252

Note. R square =0.225, F(5, 288) = 16.681, p<0.001
*p<0.05; **p<0.01; ***p<0.001;

Week's influence on number quantity. Since there was no significant linear effect of week on the weekly message sums, I conducted one-way repeated ANOVA to examine how the weekly message sums changed from week to week in each version of the course by using the weekly message sums as dependent variables and week as the independent variable.

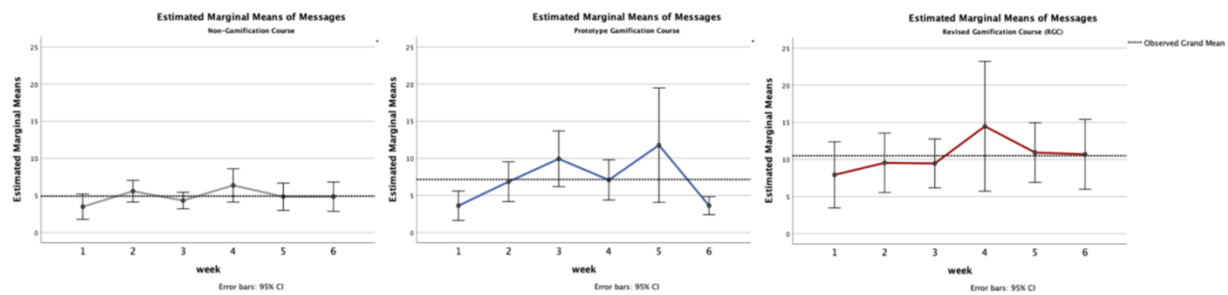

Figure 6 *Estimated Marginal Means of Messages Posted in Each Week with 95% CI in the Three Versions of the Course (From left to right: The NGC, the PGC, the RGC)*

In the NGC (left in Figure 6), there was a significant difference between the weekly message sums, F (3.156, 69.427) = 4.159, $p < 0.01$ (Mauchly's test was violated, therefore I reported the corrected F value based on Greehouse-Geisser). The effect size, partial eta square, was 0.159, which was a large effect according to Cohen (1988). In the PGC (middle in Figure 5), differences between the weekly message sum were also significant, F (1.668, 20.011) = 4.451, $p < 0.05$. It had an even larger effect size, as the partial eta square was 0.271. In the RGC (right in Figure 5), the differences of the weekly message sum were not significant F (5, 60) = 1.921, p = 0.104. The effect size was smaller—the partial eta square was 0.138—which was a medium effect size according to Cohen (1988).

Given the values of the effect sizes, the influence of week on the weekly message sum was the largest in the PGC. As Figure 5 and the descriptive statistics in Table 15 showed, students in the PGC posted fewer messages in the discussion forum in week 1 and week 6. The pairwise comparison in the one-way repeated-measures ANOVA showed significant differences between week 1 and week 2 ($p < 0.01$), and week 1 and week 3 ($p < 0.01$). Even though there was variation among other weeks, such as week 6 and week 5, there was no significant correlation, which indicated the high level of variability of students between the weeks, resulting in the non-significant results. In the RGC, students posted more messages in week 4 than other weeks; the insignificance was also due to the high level of variability. Students in the NGC had also presented different posting behaviors from week to week. The pairwise comparison showed the major differences came from week 1 and week 2 ($p < 0.01$), and week 1 and week 4 ($p < 0.01$).

The results from the ANOVA test showed there were large variabilities of students' posting behaviors from week to week in the two gamification versions of the course. One design element that could have caused the changes in the gamification design was the facilitator bonus. It is possible that when students were the facilitators they posted more messages in comparison to the week when they were not facilitators. Therefore, I used multiple regression to investigate whether the facilitator bonus influenced students' message posting behaviors.

The interaction effect of facilitator status and gamification conditions in the weekly message sum. Since students had a chance to be facilitators of the discussion forum for one week only in the last four weeks, the regression model only included data from these four weeks. Table 17 presents descriptive statistics of the number of messages that students posted each week under the categories of facilitators and non-facilitators. Except for three cases (PGC in week 4; NGC and RGC in week 5), facilitator students posted more messages than non-facilitator students in each week. Therefore, the following regression analysis focused on whether there were influences of the gamification design on the posting behaviors of students when they were assigned the responsibility of facilitation.

Table 17 *The Descriptive Statistics of Messages Posted by Facilitators and Non-Facilitators in Each Week (the first two weeks were facilitated by the instructor)*

Week	Version	Facilitator	Mean	N	SD	Median	Min	Max	Kurtosis	Skewness
W3	NGC	Non-Facilitator	4.05	19	2.345	4	1	9	0.122	0.883
		Facilitator	5.5	4	3.697	6	1	9	-2.716	-0.475

	PGC	Non-Facilitator	8.22	9	5.674	6	0	17	-0.735	0.452
		Facilitator	13.75	4	6.292	13	8	21	-3.976	0.316
	RGC	Non-Facilitator	8.4	10	5.317	7	2	17	-1.2	0.397
		Facilitator	13	3	5.196	10	10	19	.	1.732
W4	NGC	Non-Facilitator	5.44	16	4.647	3	0	16	-0.087	0.893
		Facilitator	8.43	7	6.133	7	3	20	1.198	1.323
	PGC	Non-Facilitator	7.4	10	4.695	5.5	2	17	0.288	0.917
		Facilitator	6	3	4.359	8	1	9	.	-1.63
	RGC	Non-Facilitator	10	10	11.392	6.5	1	41	7.76	2.67
		Facilitator	29.33	3	15.503	29	14	45	.	0.097
W5	NGC	Non-Facilitator	4.83	18	4.315	4	0	16	1.083	1.112
		Facilitator	4.8	5	4.438	3	1	12	1.566	1.393
	PGC	Non-Facilitator	5.89	9	3.516	5	1	11	-1.485	0.007
		Facilitator	25	4	16.753	19	13	49	2.036	1.526
	RGC	Non-Facilitator	11.22	9	6.87	12	0	20	-1.14	-0.258
		Facilitator	10.25	4	6.994	10	2	19	1.123	0.208
W6	NGC	Non-Facilitator	4.76	17	5.166	3	0	19	2.509	1.608
		Facilitator	5	6	2.449	5.5	1	7	-0.3	-0.857
	PGC	Non-Facilitator	3.18	11	1.834	3	0	7	1.225	0.507
		Facilitator	6	2	1.414	6	5	7	.	.
	RGC	Non-Facilitator	8.1	10	5.801	5.5	4	22	3.259	1.887
		Facilitator	19.33	3	8.145	23	10	25	.	-1.615

Using each student's weekly message sum as the dependent variable, students' facilitator status and the course versions were used as the independent variable in the regression model. The model summary and the coefficients are presented in Table 18. With controlling the number of threads in each week, students' facilitator status had a significant positive influence on the number of messages posted in each week (B = 4.726, p < 0.001). The facilitator students posted more messages than the non-facilitator students.

Therefore, the two interaction items of the course version and the facilitator status were added in the regression model. The adding of the interaction items caused a significant change in the regression model $F(2, 189) = 5.269$, p < 0.01. Specifically, the effects of being a facilitator on the weekly message sum were different between the NGC students and the RGC students, the difference was statistically significant.

$$Y_{NoM\_W} = a + B_1*NoT\_W + B_2*FS + B_3*Original + B_4*Prototype + B_5*Original*FS + B_4*Prototype*FS + e \quad (2)$$

Table 18 *Sequential Multiple Regression Analysis Summary Explaining Weekly Message Sum from Gamification Condition, Week, and the Interaction of Gamification Condition and Facilitator Status, When Controlling for the Number of Thread in the Week and Facilitator Status (N=196)*

	B	SE	Beta	95.0% Confidence Interval for B		R^2	ΔR^2
				Lower Bound	Upper Bound		
Step 1						0.241	0.241
Constant	7.885	1.280		5.36	10.41		
N of Thread Centered	1.477	0.574	0.256*	0.345	2.608		
Facilitator status	4.726	1.078	0.278***	2.6	6.852		
Original	-2.774	1.756	-0.189	-6.238	0.689		
Prototype	-0.704	1.616	-0.043	-3.892	2.483		
Step 2						0.281	0.04
Constant	7.015	1.337		4.377	9.653		
N of Thread Centered	1.522	0.562	0.264**	0.413	2.63		
Facilitator status	7.922	2.023	0.466***	3.93	11.913		
Original	-0.988	1.848	-0.067	-4.632	2.657		
Prototype	-0.602	1.750	-0.036	-4.055	2.851		
FS x Original	-6.882	2.547	-0.297**	-11.907	-1.857		
FS x Prototype	-0.094	2.863	-0.003	-5.741	5.554		

Step 1: R square =0.241, F(4, 191) = 15.134, p<0.001
Step 2: R square =0.281, F(6, 189) = 12.297, p<0.001
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Next, multiple regression analysis was used for each course separately to examine the effect of being a facilitator; the model summary is in Table 19. In the RGC and PGC, the facilitator posted significantly more messages than non-facilitator students. But in the NGC, there was no significant difference between facilitator and non-facilitator students.

This result explained the non-significant differences in the repeated ANOVA's following pairwise analysis in the gamification versions of the course. Students' posting behaviors change from week to week was probably due to the role they played. When they were the facilitators they posted more messages to interact with peers and to keep the discussion moving forward. However, this phenomenon was not observed in the NGC. Therefore, it is possible that the 50 bonus points in the gamification versions of the course increased facilitator's posting frequency. Though there were few students that did receive the bonus, most students worked towards winning the bonus.

Table 19 *Multiple regression analysis summaries for explaining number of messages posted in the week from facilitator status, when controlling for the number of thread in the week in the three versions of the courses*

	NGC (N=92)		PGC (N=52)		RGC(N=52)	
Variable	B (S.E.)	R^2	B (S.E.)	R^2	B (S.E.)	R^2
Constant	4.82***	0.115**	6.216***	0.294**	9.366***	0.152*
	(0.484)		(1.088)		(1.382)	
Facilitator Status	1.065		7.519**		8.075**	
	(0.995)		(2.189)		(2.767)	
N of Thread Centered	1.413**		2.862*		-1.464	
	(0.457)		(1.143)		(2.396)	

* p<0.05; ** p<0.01; *** p<0.001

Quantity Comparison summary. Overall, students in the gamification versions of the course posted more messages on average than students in the NGC on both the semester and week scales. Moreover, the facilitator bonus experience points had significant impact on students' message posting behaviors. There were no significant differences of the message posting patterns between the two gamification versions of the course. These results concluded that the gamification design in the study encouraged students to post more messages in the discussion forums, and the facilitator bonus in the gamification design had larger effects on students' posting behaviors.

Interaction Dynamic comparison of the three version of the course

The previous section showed the positive influences of gamification design on the quantity of messages. To examine whether gamification design influenced the peer interaction dynamic, in this section I compare several SNA measures between the three versions of the course, including the local degree measures, reciprocity, and density and centralization scores. The data included in this analysis included only interaction between peers, meaning that the interaction between students and the instructor and replying to oneself were eliminated from the interaction dynamic data set. I calculated these SNA measures on both the semester and week scales in order to examine the changing patterns of the interaction dynamic over a semester, and whether there were differences between the three versions of the course.

In this part, I first compared the two local degree measures. In-degree represented the variety of repliers that a student had, which was the number of peers that a student received comments from. Out-degree represented the broadness of a student's interaction, which was the number of peers that a student sent comments to. Therefore, these two local degree measures illustrated the interaction dynamic of students. For example, if a student posted a higher number of comments in the week with a lower out-degree measure, this indicated the student replied to a small number of peers multiple times. The value of the two local degree measures was limited to the size of the group. For a larger group size, it took more time and energy to be connected with others. Students in the NGC were split up into two groups in the course, with one group of 12 students, and the other of 11 students. Therefore, the group sizes were similar to the PGC (N=13) and RGC (N=13), but not equal to each other. To be able to compare the in-degree and out-degree between the three versions of the course, I used the measures that represented the percentage of peers that a student had interacted with (in- and out-) in one group (Freeman, 1979).

According to Yacci (2000), a complete interaction in online discussion forums should be a complete message loop. In this study, I calculated the dyad ratio in each thread to reveal the proportion of existed message loops. Therefore, the reciprocity presented the chances that a student could receive a reply after he/she sent out a message to a peer in the discussion.

Finally, I examined the interaction dynamic in the group level. Both directed and undirected density were calculated for each group to reveal how well the student was connected within the group. Additionally, the centralization score was calculated to further explain whether the interaction was evenly distributed throughout the group. For example, a high value of the centralization score with a higher density score meant that the high density of a group was due to a small portion of active members who interacted with every classmate.

Semester in-degree and out-degree comparison. I first compared the two local degree measures at the semester scale between the three versions of the course. The descriptive statistics of the in-degree and out-degree in Table 20 show students in the gamification versions of the course had higher in-degree and out-degree with smaller variance. The Kruskal-Wallis H test presented a significant difference between the in-degree values, *Chi-square* $(2, N = 49) = 8.457$, $p = 0.015$, with a mean rank score of 18.74 for NGC, 30.73 for PGC, and 30.35 for RGC. Students in the gamification versions of the course had higher in-degree values than students in the NGC. Specifically, the difference between the RGC and NGC was statistically significant ($U=79$, $p=0.02$), as well as between the PGC and NGC ($U = 76$, $p = 0.015$), while there was no significant difference of in-degree values between RGC and PGC. The results indicate that students in gamification versions of the course received a broader range of peers' replies than students in NGC.

On the contrary, the Kruskal-Wallis Test did not present a significant difference of out-degree values between the students in the three versions of the course by using (*Chi-square* (2, N = 49) = 4.091, p = 0.129), with a mean rank score of 20.74 for NGC, 29.53 for PGC, and 28.00 for RGC. The result indicated that students sent messages to a similar amount of students over the semester in the three versions of the course. Students posted more messages in the gamification versions of the course, however, the numbers of peers they sent comments to were about the same. This indicated that students in the gamification versions of the course had more turns of conversion with peers, which is a prerequisite for knowledge building discourse while the lengthy discussion could also be social interactions.

Table 20 *In-degree and out-degrees descriptive statistics in the three versions of the course*

	Version	Mean	S.D.	Median	Min	Max	Kurtosis	Skewness
In-Degree	NGC (N=23)	0.766	0.168	0.800	0.400	1	-0.450	-0.671
	PRC (N=13)	0.885	0.093	0.833	0.750	1	-1.387	0.079
	RGC (N=13)	0.878	0.111	0.917	0.670	1	-0.784	-0.474
Out-Degree	NGC (N=23)	0.766	0.220	0.900	0.270	1	-0.659	-0.682
	PRC (N=13)	0.885	0.142	0.917	0.500	1	3.809	-1.769
	RGC (N=13)	0.878	0.121	0.917	0.580	1	1.721	-1.156

Weekly degree comparison. The semester degree measures revealed the accumulated interactions the students had during the semester, but it did not reveal how many peers they interacted with each week. Therefore, I calculated and compared students' in-degree and out-degree measures in each week of the three versions of the course. Multiple regression was used separately. The degree measures were the dependent variables with the course version and weeks as the independent variables, and the number of threads in each week and students' facilitator status in each week as the controlling variables.

In-degree weekly. As Table 21 shows, in both courses, the mean in-degree were lower in the first two weeks because the instructor was the facilitator in the first two weeks. Some messages that students posted were sent to the instructor instead of peers. Therefore, they interacted with fewer peers in the first two weeks. It was noticeable that in all three versions of the course, there were students who did not receive any comments in the discussion forums where the in-degree value was 0. Usually, if a student posted later in the week, it had greater chances that she/he would not receive any responses from peers. Even though this happened in all three versions of the course, it happened most in the NGC. It also supported the semester comparison results that the comments were sent to few students causing a more centralized interaction pattern. On average, students in the RGC had higher in-degree values in each week.

Table 21 *In-degree descriptive statistics in each week in the three versions of the course*

	Version	Mean	SD	Median	Min	Max	Kurtosis	Skewness	Zero replies*
Week 1	NGC (N=23)	0.076	0.115	0	0	0.36	1.833	1.637	13
	PGC (N=13)	0.115	0.130	0.083	0	0.33	-1.041	0.645	6
	RGC (N=13)	0.250	0.180	0.25	0	0.58	-0.534	0	3
Week 2	NGC (N=23)	0.170	0.145	0.1	0	0.45	-0.618	0.611	5
	PGC (N=13)	0.244	0.150	0.333	0	0.42	-1.079	-0.675	2
	RGC (N=13)	0.378	0.188	0.417	0.08	0.67	-1.253	0.018	0
Week 3	NGC (N=23)	0.322	0.261	0.3	0	0.91	0.11	0.889	3
	PGC (N=13)	0.468	0.286	0.5	0	0.83	-1.075	-0.404	1
	RGC (N=13)	0.417	0.270	0.5	0	0.83	-0.933	-0.226	2
Week 4	NGC (N=23)	0.397	0.242	0.455	0	0.82	-0.895	-0.357	3
	PGC (N=13)	0.391	0.260	0.417	0	0.75	-1.364	-0.051	1
	RGC (N=13)	0.430	0.272	0.417	0.17	0.83	-1.595	0.417	0
Week 5	NGC (N=23)	0.333	0.283	0.364	0	0.73	-1.476	0.152	7
	PGC (N=13)	0.410	0.262	0.25	0.17	0.92	-0.541	0.917	0
	RGC (N=13)	0.462	0.206	0.5	0	0.75	0.61	-0.78	1

Week 6	NGC (N=23)	0.317	0.282	0.2	0	0.73	-1.617	0.345	5
	PGC (N=13)	0.224	0.251	0.167	0	0.75	1.623	1.605	2
	RGC (N=13)	0.462	0.276	0.417	0	1	0.445	0.547	1

Note: *Zero replies: the number of students who did not receive any comments from peers in the week

$$Y_{IN} = a + B_1\text{*NoT\_W} + B_2\text{*FS} + B_3\text{*Week} + B_4\text{*Original} + B_5\text{*Prototype} + e \quad (3)$$

The same dummy code (Table 6) was used in the regression model to compare the weekly in-degree value, and the RGC were used as the reference group. The variables in the model significantly explained the variation of the weekly in-degree, $F(5, 288) = 41.33$, $p < 0.001$. The adjusted R square was .402, indicating 40.2% of the variance in the weekly in-degree was explained by the model. The model summary and the coefficients are shown in Table 22. Students in the RGC had higher in-degree than students in the NGC ($B = -0.094$, $p < 0.01$) and students in the PGC ($B = -0.066$). The results indicated in each week, the RGC students received comments from more peers than the NGC students and PGC students, while the difference between the RGC and PGC was not statistically significant.

Additionally, week presented a positive effect at the in-degree value. However, when the interaction items of the gamification versions and week were added in the model, they did not cause a significant change in R square, $F(2, 286) = 2.21$, $p = 0.112$. Therefore, in all three versions of the course, the in-degree values increased week by week.

Table 22 *Multiple Regression Analysis Summary Explaining Weekly In-degree from Course Condition, and Week, When Controlling for the Number of Thread in the week and Facilitator Status(N=294)*

	B	S.E.	Beta	95.0% Confidence Interval for B	
				Lower Bound	Upper Bound
Constant	0.185	0.063		0.061	0.308
Number of Thread in the Week	0.021	0.014	0.094	-0.006	0.049
Facilitator Status	0.379	0.032	0.551***	0.315	0.442
Original	-0.094	0.035	-0.185**	-0.164	-0.025

Prototype	-0.066	0.035	-0.115	-0.135	0.004
Week	0.015	0.008	0.101*	0	0.03

Note. R Square = 0.418, F(5, 288) = 41.33, p<0.001
*p<0.05; **p<0.01; ***p<0.001;

Out-Degree weekly. The descriptive statistics for the out-degree of each week in the three versions of the course are presented in Table 23. The average out-degree was higher in the RGC. The 0 of the out-degree indicated that there were students who did not send out messages to any classmates. The descriptive data showed that more NGC students did not send messages to peers in each week, especially in the first two weeks when the instructor of the course was the discussion facilitator.

Table 23 *Out-degree descriptive statistics in each week in the three versions of the course*

	Version	Mean	SD	Median	Min	Max	Kurtosis	Skewness	Zero comments*
Week 1	NGC (N=23)	0.076	0.109	0	0	0.27	-0.625	1.034	14
	PGC (N=13)	0.115	0.150	0	0	0.42	-0.584	0.925	7
	RGC (N=13)	0.250	0.257	0.167	0	0.75	0.482	1.271	2
Week 2	NGC (N=23)	0.170	0.175	0.1	0	0.45	-1.342	0.483	9
	PGC (N=13)	0.244	0.185	0.333	0	0.5	-1.663	-0.266	3
	RGC (N=13)	0.378	0.225	0.417	0.08	0.83	0.189	0.794	0
Week 3	NGC (N=23)	0.322	0.237	0.3	0	0.8	-0.371	0.472	3
	PGC (N=13)	0.468	0.185	0.5	0	0.67	2.298	-1.371	1
	RGC (N=13)	0.417	0.183	0.417	0.08	0.67	-0.681	-0.278	0
Week 4	NGC (N=23)	0.397	0.250	0.3	0	0.82	-1.04	0.394	1
	PGC (N=13)	0.391	0.208	0.417	0	0.67	-0.503	-0.46	1
	RGC (N=13)	0.430	0.254	0.417	0.08	0.83	-0.961	0.452	0
Week 5	NGC (N=23)	0.333	0.239	0.3	0	0.82	-1.075	0.2	3
	PGC (N=13)	0.410	0.229	0.333	0.08	0.92	0.579	0.746	0
	RGC (N=13)	0.462	0.256	0.5	0	0.75	-0.365	-0.747	2
Week 6	NGC (N=23)	0.317	0.212	0.3	0	0.64	-1.286	-0.064	3
	PGC (N=13)	0.224	0.120	0.25	0	0.42	0	0.041	1
	RGC (N=13)	0.462	0.217	0.417	0.17	0.83	-1.271	0.301	0

Note: *Zero comments: the number of students who did not send any comments to the peers.

$$Y_{IN} = a + B_1*NoT\_W + B_2*FS + B_3*Week + B_4*Original + B_5*Prototype + e \quad (4)$$

Similar to the weekly in-degree comparison, a multiple regression was used for the out-degree comparison. With the weekly out-degree as the dependent variable, the dummy variables of the course versions (RGC as the reference group) and week served as the independent variable. With controlling the number of thread in each week and students' facilitator status, the model significantly explained the variation of the weekly out-degree, $F(5, 288) = 14.235$, $p < 0.001$. The adjusted R square was .184, which indicated that 18.4% of variation of the weekly out-degree was explained by the variables. The RGC students had higher out-degree; however, the out-degree value in each week did not significantly differ between the RGC and NGC (B = -0.075), and between the RGC and NGC (B = -0.05).

Table 24 *Sequential Multiple Regression Analysis Summary Explaining Weekly Out-degree from Course Version, Week, and the Interaction of Course Version and Week, When Controlling for the Number of Thread in the Week, Facilitator Status (N=294)*

	B	S.E.	Beta	95.0% Confidence Interval for B		R_2	ΔR_2
				Lower Bound	Upper Bound		
Step 1						0.198	0.198
Constant	0.124	0.068		-0.01	0.258		
Number of Thread in the Week	0.035	0.015	0.167*	0.005	0.065		
Facilitator Status	0.125	0.035	0.196***	0.056	0.194		
Original	-0.075	0.038	-0.158	-0.15	0.001		
Prototype	-0.05	0.038	-0.094	-0.125	0.025		
Week	0.026	0.008	0.19**	0.01	0.042		
Step 2						0.216	0.018
Constant	0.137	0.069		0.002	0.272		
Number of Thread in the Week	0.06	0.018	0.286**	0.002	0.272		
Facilitator Status	0.117	0.035	0.184**	0.024	0.096		
Original	-0.22	0.07	-0.467**	0.048	0.185		
Prototype	-0.105	0.078	-0.197	-0.357	-0.083		
Week	-0.01	0.019	-0.074	-0.259	0.049		

Week x Original	0.053	0.021	0.472*	-0.047	0.027
Week x Prototype	0.024	0.022	0.181	0.011	0.095

Note. Step 1. R Square = 0.198, F(5, 288) = 14.235, p<0.001

Step 2. R Square = 0.216, F(7, 286) = 11.286, p<0.001

**p*<0.05; ***p*<0.01; ****p*<0.001

Week had a significant positive effect on the out-degree. As time went by, students replied to more and more peers in the discussion forum. When adding the interaction items of week and gamification versions, the R square changed significantly, *F change* (2, 286) = 3.335, $p < 0.05$. The adjusted R square was increased to .197. Thus, week had different levels of influences on the out-degree values in the three versions of the course. Particularly, the out-degree changed week to week in different ways in the NGC and RGC, and the difference was statistically different ($B = 0.053$, $p = 0.014$).

In order to specify the different weekly change pattern, three separate multiple regressions were run for each version of the course with the out-degree as the dependent variable, week as the independent variable, and the number of thread and facilitator status as the control variables. The results are displayed in Table 25. Only in the non-gamification course did the out-degree increase as time went by, indicating that students in the non-gamification courses interacted with fewer peers at the beginning of the course when the instructor was the discussion facilitator. In both the versions of gamification course, there was no significant influence of week on out-degree. Such results indicated that students in the gamification versions of the course sent messages to a similar number of peers in the 6 weeks of the course.

Table 25 *Multiple Regression Analysis Summaries for Weekly Out-degree from Week, When Controlling for the Number of Thread and Facilitator Status in the Week in the Three Versions of the Courses*

	NGC (N=138)		PGC (N=78)		RGC (N=78)	
Variable	B (S.E.)	R_2	B (S.E.)	R_2	B (S.E.)	R_2
Constant	-0.091	0.202**	-0.032	0.19**	0.302*	0.136*
	(0.083)		(0.108)		(0.149)	
Facilitator Status	0.087		0.124		0.165*	
	(0.051)		(0.063)		(0.027)	
N of Thread	0.062*		0.081*		-0.012	
	(0.024)		(0.032)		(0.06)	
Week	0.044***		0.01		0.036	
	(0.011)		(0.014)		(0.043)	

*$p<0.05$; **$p<0.01$; ***$p<0.001$

Reciprocity of each thread. The reciprocity score was the mutual dyad ratio, which presented the proportion of the complete interaction loop in each thread in the study. A complete interaction loop was the situation when student A sent a message to B in a thread and then received a reply from B in the thread.

Table 26 *Descriptive Statistics of the Reciprocity of Each Thread in the Three Versions of the Course*

Version	Mean	SD	Median	Min	Max	Kurtosis	Skewness
NGC (N=36)	0.28	0.21	0.26	0.00	0.69	-0.750	0.386
PGC (N=20)	0.40	0.22	0.41	0.09	1.00	1.773	1.002
RGC (N=28)	0.45	0.21	0.49	0.11	0.83	-1.127	-0.114

The descriptive statistics of the reciprocity scores in Table 26 show the threads in the gamification versions of the course had more mutual dyads on average. Students in the gamification version of the course were more likely to respond to the peers who sent them a message. The distribution of the reciprocity scores of each thread was not normally distributed in each version of the course; therefore, the non-parametric tests were used to compare the differences. The result from the Kruskal-Wallis H test showed a significant difference of the reciprocity scores in the three versions of the course, *Chi-Square* $(2, N = 84) = 8.597$, $p = 0.014$, with a mean rank score of 33.90 in the NGC, 45.33 in the PGC, and 51.54 in the RGC. Next, Mann-Whitney tests were used to compare the pairs of the three versions of the course. The significant difference was only found between the NGC and the RGC ($U = 301$, $p = 0.006$).

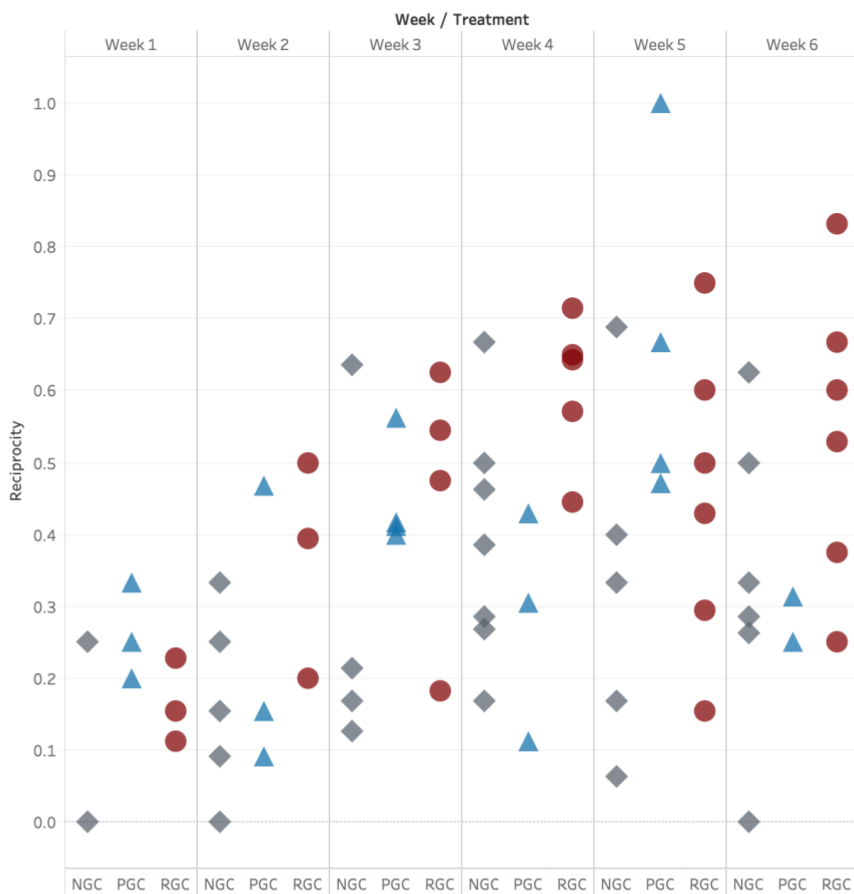

Figure 7 *Reciprocity of Each Thread in Each Week in the Three Versions of the Course*

Figure 7 presents the reciprocity score of each thread in the three versions of the course by week. In the first two weeks, the reciprocity scores were lower in all the three courses. The reason was that the discussion facilitator in the first two weeks was the course instructor, so that students interacted with the instructor more frequently than with their peers. Therefore, the interaction loops completed by students occurred less. In the following four weeks, the reciprocity scores increased in all three versions of the course. Additionally, the reciprocity scores of most RGC thread were higher than in the other versions of the course. Overall, in the RGC, students were more like to write a reply to the classmates who sent them a message in each week.

Density and Centralization Comparison. The local degree measure and the mutual dyad described students connection in the three versions of the course in the individual level and the thread level, respectively. In this section, I compare the group level connection measure, density and centralization scores at both the semester and week scales, which revealed the overall connection in each version of the course.

Semester Density and centralization. The density and centralization scores are presented in Table 27. The density values of the two gamification versions of the course were higher than the non-gamification version of the course. In addition to the higher density values, the centralization scores of the gamification versions of the course were also smaller. From these data, it was evident that overall there were more connections of students in the gamification versions of the course. Moreover, the connections were slightly more evenly distributed among students.

Table 27 *Density and Centralization of the Semester in The Three Versions of the Course*

Version	Directed Density	Directed Links	Undirected Density	Undirected Links	Centralization Score
NGC (N=23)	0.763	93	0.908	55	0.110
PGC (N=13)	0.885	138	0.949	74	0.060
RGC (N=13)	0.878	137	0.936	73	0.076

Weekly Density. Figure 8 displays the density value of each week in the three versions of the course. The density scores in the first two weeks were lower in all three versions of the course. In RGC, the density presented an increasing pattern over the course period. While in the PGC and the NGC, the density scores increased in the first half of the semester, then presented a decreasing pattern. These data indicated that students in the RGC maintained the group interaction level during the course, while in the other two courses, the group interaction levels were not as stable as in the RGC.

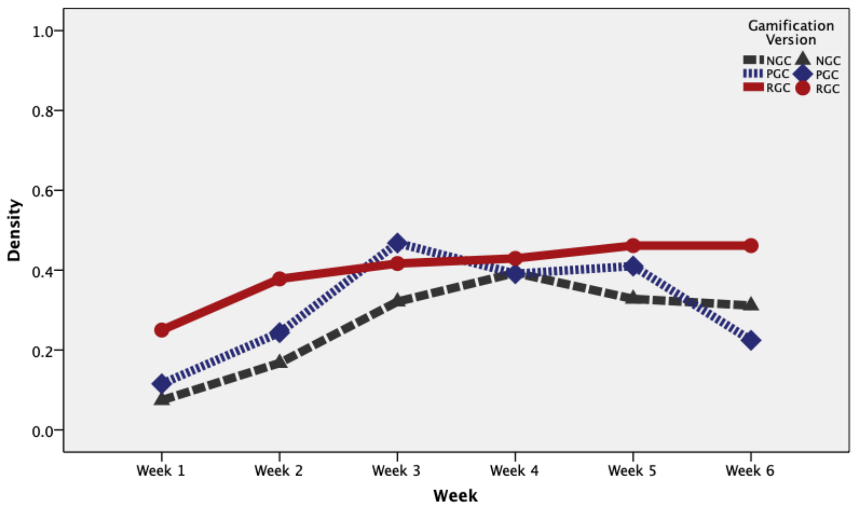

Figure 8 *Density in Each Week in the Three Versions of the Course*

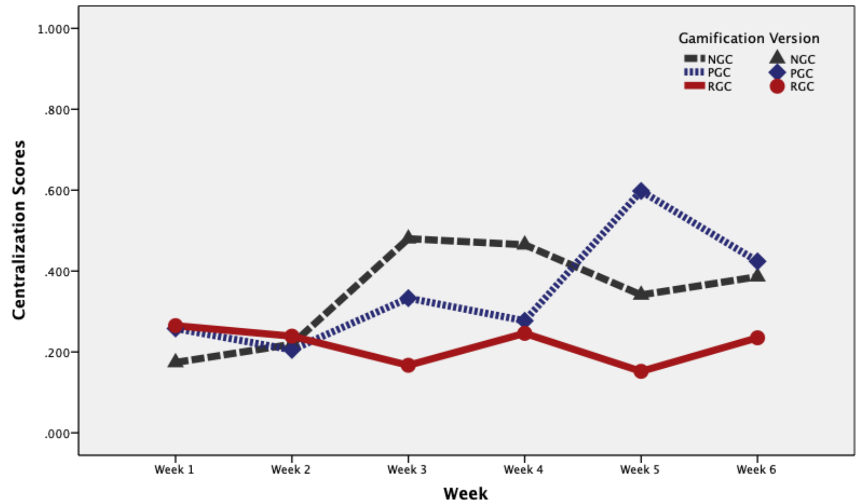

Figure 9 *Centralization Scores in in Each Week in the Three Versions of the Course*

Figure 9 presents the weekly data of the centralization scores in the three versions of the course. The weekly centralization scores were all higher compared to their semester value. This indicated that in each week, the interaction was more likely to be centered on certain students, such as the facilitators. For instance, in the PGC, the density score of week 5 was relatively high (0.41) among weeks. However, it also had one of the highest centralization scores, which was 0.60. In this week, one PGC facilitator won the facilitator bonus. However, the centralization scores in RGC were relatively small among the three versions of the course. Similarly, the centralization score was higher in week 4 and week 6 when there were facilitators who won the bonus experience points.

Interaction dynamic comparison summary. In this section, I compare the several SNA measures to examine the interaction dynamic in the three versions of the course. Overall, the interaction in the two gamification versions of the course was more evenly distributed while the interaction in the non-gamification version of the course was more centralized. This conclusion came from the comparisons of the three types of SNA measures. First, students received comments from more peers in the gamification versions of the course over the semester and on a weekly basis. The number of peers that students sent messages to was similar over the semester and on a weekly basis in the three versions of the course. Additionally, the NGC students replied to fewer peers as the beginning of the course, while the number of classmates that the PGC and RGC students sent messages to were relatively stable in each week during the course. Though students sent messages to a similar amount of students in the three version of the course, the number of classmates that students received messages from were different. One explanation was that a few students in the NGC received the majority of the comments from their peers that led to a situation where the majority of students had lower in-degree values, while the PGC and RGC students sent messages to a broader range of classmates. Second, the centralization scores were smaller in the gamification versions of the course, which supported that the interaction was not dominated by few students in these two courses. Third, the reciprocity scores showed that there were more mutual interactions in the gamification versions of the course, meaning the students' comments were more likely to be replied to by peers in the two course versions. Therefore, based on the three evidences, the students' interaction in the gamification versions of the course were more evenly distributed; particularly, there were more students who received comments from various students, and their comments to their classmates were more likely to receive replies.

Interaction Quality Comparison

Since the focus of the study was students' interaction, in this section, the data sample only included the discussions between students. All the interaction that involved the instructor was excluded from the data sample. Two major analysis techniques were used to describe and compare the differences of the interaction quality in the three versions of the course. MANOVA was used to compare the differences in the types of response students posted in terms of knowledge building. LSA was used to detect the significant two-response chains presented in the three versions of the course. In this section, I first present the interaction quality comparison in the three versions of the course at the semester scale, then at the weekly scale.

Semester Interaction Quality Comparison. When comparing students' response types, I used the percentage instead of the count of each type of response that a student posted as the dependent variable.

Table 28 presents the descriptive statistics for the percentage of students' response in each type. According to the descriptive data, the Initial response, which was usually the replies to the discussion questions, were posted more often by students. The next most frequent posted response types were the New-info response and the Building-on response. The former one was a response that added new information such as examples, background, and context. The latter one was the response that advanced the argument, including expressing disagreement, proposing or negotiating new argument, and making conclusions. Finally, the percentage of the Paraphrase response was the lowest. Besides the four type of response, there were also responses in the academic discussion thread that were not academic related. Since the number of those messages was only 2% in total, I did not include them in the comparison. Based on the minimum of each category, there were students who only posted the Initial response and never posted another type of response in the discussion forums.

Table 28 *Descriptive Statistics of Each Type of Response*

	Initial Response	Paraphrase Response	New-info Response	Building-on Response
Mean	0.35	0.15	0.24	0.24
N	49	49	49	49
SD	0.18	0.11	0.12	0.14
Median	0.30	0.13	0.24	0.26
Minimum	0.07	0	0	0
Maximum	1	0.5	0.46	0.53

Kurtosis	2.59	0.75	-0.64	-0.21
Skewness	1.40	0.78	-0.01	0.04

Table 29 shows the descriptive statistics of the percentages of students' response in each type by the course version. According to the table, the responses that the RGC and PGC students posted contained less Initial response and Paraphrase response and more New-info response and Building-on response compared to the NGC students. Next, I conducted a MANOVA to examine whether there were statistically significant differences between the three versions of the course on a linear combination of the percentages of the four response types.

Table 29 *Descriptive Statistics of Each Type of Messages in Each Course*

		Mean	N	SD	Median	Min	Max	Kurtosis	Skewness
Initial Responses	NGC	0.40	23	0.20	0.36	0.13	1	2.70	1.32
	PGC	0.32	13	0.16	0.29	0.14	0.71	2.42	1.43
	RGC	0.28	13	0.16	0.26	0.07	0.73	5.54	1.95
Paraphrase Responses	NGC	0.18	23	0.13	0.18	0	0.5	0.34	0.53
	PGC	0.13	13	0.10	0.09	0	0.31	-1.05	0.56
	RGC	0.12	13	0.07	0.13	0.02	0.26	-0.27	0.49
New-info Responses	NGC	0.18	23	0.11	0.17	0	0.41	-0.20	0.15
	PGC	0.28	13	0.11	0.31	0.13	0.46	-1.19	-0.01
	RGC	0.29	13	0.10	0.29	0.13	0.44	-1.01	-0.11
Building-on Responses	NGC	0.22	23	0.17	0.21	0	0.53	-0.98	0.11
	PGC	0.26	13	0.12	0.23	0.13	0.53	1.45	1.21
	RGC	0.28	13	0.11	0.26	0.07	0.52	1.97	0.29

Table 30 presents the Pearson correlation coefficients between the six pairs of variables. According to the table, there was a non-significant negative correlation between the percentage of the Initial response and the Paraphrase response. However, the correlation coefficients of the percentage of the Initial response and the New-info response, and the Initial response and the Building-on response showed statistically significant negative relationships. Since the variable I used was the percentage of each type of response that a student posted, the above negative relationship meant that students who posted more Initial responses usually posted less New-info and Building-on messages. These students usually just answered the discussion questions rather than replying to their peers' opinions. Additionally, there was a significant negative correlation between the percentage of the Paraphrase response and the Building-on response. This indicated that students who posted more Paraphrase responses contributed less Building-on responses to the online discussion. These students did reply to their peer's opinions while they just simply agreed with what they peer wrote. The dependent variables presented a moderate correlation, so it was appropriate to use MANOVA.

Table 30 *Intercorrelation for Percentage of Each Type of Response (N=49)*

	Initial Responses	Paraphrase Responses	New info Responses	Building-on Responses
Initial Responses	--			
Paraphrase Responses	-0.257			
	0.075			
New info Responses	-.514**	-0.21		
	<0.001	*0.148*		
Building-on Responses	-.575**	-.303*	-0.027	--
	<0.001	*0.034*	*0.851*	

**p*<0.05; ***p*<0.01; ****p*<0.001

The distribution of data was normal; the Levene's Test did not reject the null hypothesis of the homogeneity of variance and neither did the Box's M Test for the equality of covariance (p = 0.121). Table 31 presents the four methods of the MANOVA statistics. All four statistics showed a significant difference between the three versions of the course on the proportions of the message types.

Table 31 *Multivariate Test Statistics*

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's Trace	0.38	2.582	8	88	0.014	0.19
Wilks' Lambda	0.644	2.644	8	86	0.012	0.197
Hotelling's Trace	0.514	2.701	8	84	0.011	0.205
Roy's Largest Root	0.425	4.679	4	44	0.003	0.298

Discriminant analysis. The discriminant analysis was used in order to closely examine the contribution of each response type on the differences of the course versions.

Based on the characteristic vectors calculated by SPSS, there were two new variables Z1 and Z2, carrying 82.7% and 17.3% information separately, which have been used to describe the differences of the percentages of each response type in the three versions of the course. The equations of Z1 and Z2 were as follows:

Z1 = -14.68 + 12.51*Initial + 11.42*Paraphrase + 21.20*New-info + 15*Building-on

Z2 = -24.09 + 25.18*Initial + 27.16*Paraphrase + 23.58*New-info + 23.73*Building-on

As Z2 only carried 17.3% information, Z1 discriminated the response types in the three versions of the course more powerful. From the first equation above it can be found that the coefficient of the percentage of the New-info response and the Building-on response was larger than the constant, since the values of each variable were all numbers from 0 to 1, a smaller Z1 value could result from the smaller percentages of the New-info response and Building-on response.

Taking Z1 as the X axis and Z2 as the Y axis, Figure 10 shows the distribution of three versions of course design. Z1 scores of the NGC students were mostly located at the lower end of X axis, as they had lower percentages of the New-info response and Building-on response, and a higher percentages of Initial response and Paraphrase response. The PGC and RGC students’ Z1 scores were mostly located at the higher end of the X axis, indicating that their messages contained more New-info response and Building-on response.

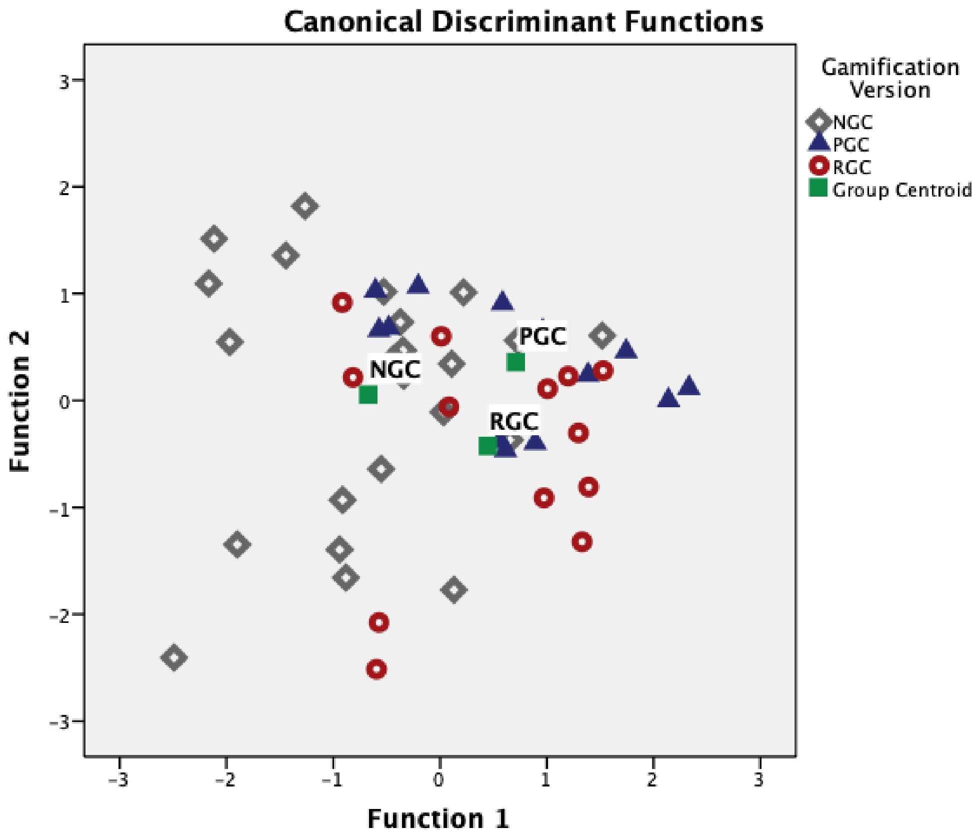

Figure 10 *Canonical Discriminant Functions*

Overall, the responses posted by students in the gamification versions of the course were more likely to add new information to the discussion topic and to build on peers' messages. Students in the gamification versions of the course posted more messages in the discussion forums and had sent messages to a similar number of peers in each week. Therefore, they had more turns of conversation with each other, which resulted in a larger proportion of New-info and Building-on response. Additionally, the badges that promoted high quality of messages might have encouraged students to create a more meaningful conversation with each other, instead of simply paraphrasing peers' argument in the discussion forums.

The Group Level Interaction Pattern Comparison. Figure 10 presents the transition diagrams of the discussion forums in the three versions of the course by using LSA. Each node represents a type of response students posted in the discussion forum; DQ stands for Discussion Questions, and N_A represents non-academic responses. The other types of responses are indicated by their first letter, such as P for Paraphrase and B for Building-on. In each diagram, the arrow points at the response occurred later (lag 1) in a two-response chain. Only the significant response chains are drawn in the diagrams, with the label of the transitional probability. The thickness of the arrow represents the value of the transitional probability from one type of response to the other.

Eight types of the response chain were found significant in results of LSA in both the semester and weekly analysis. Except the response chains that included DQ and N_A, five types of the response chains are the focus of the discussions in below. Before presenting the comparison results of the class level interaction between the three versions of the course on the semester scale, I first introduce each response chain by displaying the discussion transcript examples from the RGC. The examples from the other two versions of the course can be found in Appendix V.

The response chain I->P is an Initial response followed by a Paraphrase response. The Initial response is usually a student’s response to a DQ to present her/his opinions on the issues being discussed. A Paraphrase response is a comment that does not include any new information or statement but agreement. As in the example below, the DQ was about ICT and global learning in Cuba. Student 46 made the responses to each question. Student 42 commented on the response and showed agreement.

Student 46:

What are the common forms of ICT currently being used in Cuba?

Some of the latest technologies are Computer-Assisted Instruction (CAI) and Internet-Assisted Instruction (IAI).

How do you see Cuba forming part of the global learning?

The world is becoming smaller day after day. And I think the internet makes it easier for everyone to share ideas and projects. The quality of education (and health) in Cuba has lots of lessons to share with the world and many countries can learn from it. Third world countries, where resources are so limited, MUST study the case of Cuba and learn from it. [Code at Initial response]

Student 42:

Very interesting point Student 46. I think that is the goal which how regions can benefit from each other by taking successful regions as examples for other countries. Thanks [Code at Paraphrase response]

The response chain I->N is an Initial response followed by a New-info response. In this case, the comment to the Initial response contains new information, such as a different example, a question or response for further details, or a related issue about the Initial response. In the example below, Student 51 responded to Student 46's DQ and mentioned the country he was studying. Then Student 46 asked a follow-up question about the comparison between the two countries.

Student 51:

Student 46,

I do think that Masterplan 4 justifies the achievements you have mentioned because according to the article, in terms of student successes, some of the key features of this Masterplan are that students will have access to quality curriculum, greater support in Cyber Wellness, and the access to learn anytime and anywhere. This can absolutely lead to these students being on top in many of their subjects because they are able to get a high-quality education whenever they want it.

In Mexico, the government setup an ICT policy in elementary education in the past 10 years. They called out 23 measures for reform. Only 3 discuss teacher involvement. eleven describe specialists in education, government agencies, teacher unions, universities, and development agencies. This is an attempt by Mexico to meet the master plan 1 goals. [Code at Initial response]

Student 46:

From what you said, I can see Mexico is far behind Singapore. Do you have any justification from what you have read so far? [Code at New-info response]

The response chain I->B is an Initial response followed by a Building-on response, which includes presenting disagreement, advancing the initial statement, proposing or negotiating the proposed statement, or summarizing the discussion. In the example, the DQ was about China's effort to integrate ICT into education in rural areas. Student 43 proposed several aspects that an instructional designer can do to improve the situation. Training was mentioned simply. Then Student 42 expanded the training argument with examples and reasons.

Student 43:

Hi Student 49

The main obstacle in China situation is the asymmetric relationship between the rural population and urban modernizers. That makes it difficult for countryside to see education from the same perspective as urban areas. Farmers as stated in the article need to be informed how to work and live in the rural areas. This would require provision of ICT infrastructures and facilities for them so they can easily access to digital learning and working environment. As instructional designer, I would consider the management and budget pieces as the most important component and conditions to apply the ICT in rural educational system. Countryside may need more evaluation projects for ICT needs and potentials. And to see what will the future be look like if the country really want to apply ICT in rural areas. Many workshop training need to be developed for people who need to know what the benefit of ICT and how they can use them. Application of ICT in rural areas would absolutely benefit education in China in general because that would reduce the number of students and workers who intent to move to urban areas that have better education because of the availability of technologies and other facilities.

Student 42:

Sure Student 43

Training is one key aspect of ICT integration into countryside education. Obviously, like my countryside you might consider both pre-service and In-service training because the availability of trainers and supervisor in the countryside serve as resource reference that can be reach easily. Leaving the people alone put them in an isolated situation which makes it easier for their return to farm and activities thus neglecting to apply the learn knowledge.

The N-loop usually is a New-info response followed by another New-info response. In most cases, the N-loop is a follow-up question being answered. In the example below, students continued to discuss the possible training solutions in the countryside of China. One student mentioned government regulations. Then Student 42 asked the facilitator of the thread questions about the regional government's power in order to evaluate the solutions proposed in the thread. The facilitator, Student 49, answered the question in her comment to Student 42.

Student 42:

Hi Student 49,

I am just curious to know, how resistful of influential could regional governments be if you were integrating a national ICT in education plan in their region?

Student 49:

Hi Student 42,

In fact, the regional governments only have some power. With the control of the Party in the center, although the economy has been highly decentralized to local regions, China is not a federal system. By constitution Chinese local regions have no inherent power, and local power is granted by the central authorities. The central government is empowered to delegate power to regions, and to renounce power from regions.

The B-loop is a Building-on response followed by a Building-on response. In this case, a student's comment is inspired by the peer's posting, no matter the opinions they hold are similar or opposite. The example below also came from the China thread. Student 48 responded to the DQ by proposing "Informing everyone on the different types of technologies…". Then Student 45 added the necessity of listening to the local residents. Based on Student 45's suggestions, Student 48 added more details that an ICT program for a rural area should have, which was a development of the solutions that was proposed as first.

Student 45:

Hello Student 48,

I definitely agree with informing them with the technology, but I also think listening to them to see if new technology that is relevant to their needs to be developed. I wonder how one goes about "creating an environment" that people want to work in. I wonder if the farmers become better farmers through the use of technology, then they won't need to move away. I am not sure of what other measures could be done to keep them in their home communities, or better yet create inviting places for other to consider moving there. What do you think?

Student 48:

This reading touched on the topic of "differential distributions of power". An idea to your question could be -- with an ICT program developing, there will be someone or a group of people who are most likely in control of the ICT program...someone who has to teach the community how it works, someone to make sure the program is successful, etc. I think that it would be a good idea to make sure everyone feels like they are on the same wavelength... No one is "superior" to them just because they developed an ICT program. Since there is already a problem of "differential distributions of power", the last thing these people want in rural communities is another person saying they are in charge and that they can't do this or that. I'm not sure if this is making sense...just typing as I try to come up with an answer to your question.

I like your idea of listening to them to see what their thoughts are on technology and what would/wouldn't work. Maybe people would choose to stay in their community instead of being recruited elsewhere because they notice that their thoughts, concerns and ideas are being heard.

There were similarities of the significant chains in the three versions of the course (Figure 11). The discussion questions were followed by the Initial response in all the three versions. The

Initial responses were followed by the Paraphrase response, the New-info response, and the Building-on response in both the NGC and RGC. However, the I->B response chain was not significant in the PGC.

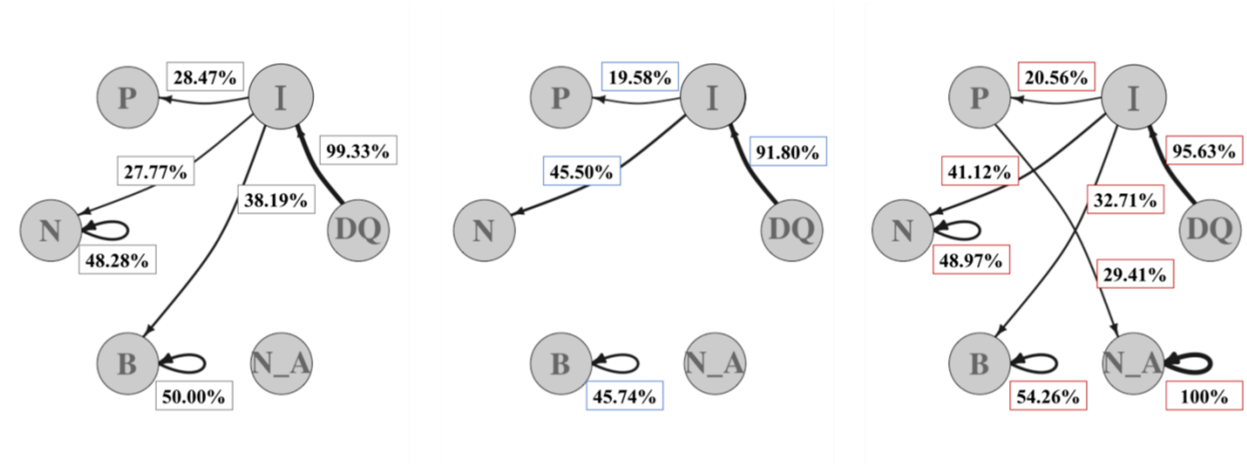

Figure 11 *The Transitional Diagrams of Each Version of the Course (from left to right: NGC, PGC, RGC). All the significant two-response chains and the chains occurred more than 5 times in total were in the diagram and were added annotation with the transitional probability.*

Moreover, in all the three versions of the course, the B-loops were significant. Even though the number of B-loop chains was smaller in the NGC (See Appendix V), the transitional probability was about the same in comparison with the other two courses. This result indicated on the semester scale the gamification design did not increase the chances of B-loops' occurrence.

The differences between the gamification versions and non-gamification version were the response chains of I->P and I->N. In the gamification versions of the course, the Paraphrase responses occurred less frequently after Initial responses compared to the non-gamification version. Furthermore, in the gamification versions, the New-info responses occurred more often after the Initial responses in comparison with the non-gamification course. This result indicated that the gamification design did increase the chances of students posting New-info responses and less Paraphrase responses after the Initial messages. These results indicated that the PGC and RGC students were more likely to ask follow-up questions to their peers' responses and less likely to simply agree with their peers.

However, the N-loop was only significant in the NGC and RGC, indicating that in these two courses, there was a greater chance that the follow-up questions were answered by peers in the two courses.

Finally, in the RGC, Non-academic responses tended to occur after a Paraphrase response and another Non-academic response. One possible reason was that students in the RGC were more motivated to post messages in order to win the experience points. Therefore, the RGC students were more likely to reply to peers; even when their peers shared agreement, they replied to that comment with a response only containing social interaction.

The semester LSA result showed that the gamification design had impacts on students' posting behaviors to some degree. Particularly, the less I->P chains and more I->N chains indicated that students did put more mental efforts in the discussion forum, but not enough to present more transition between the Building-on responses.

In summary, students in the gamification versions of the course posted more New-info responses and Building-on responses; they presented the knowledge building behaviors in the discussion forums more often. The gamification design also had influences on the class level interaction. Though the LSA results showed the class level interaction pattern had some similarities in the three versions of the course, in the two gamification versions of the course, students made fewer Paraphrase responses to their peers' Initial responses, and sent more New-info responses to the Initial responses. The impact of gamification design on the class level interaction was limited and was only on the lower-level interaction. In all three courses the transitional probability of a Building-on response following another Building-on response was about the same. Furthermore, the RGC students were more likely to use social interaction to end the online discussion with their peers.

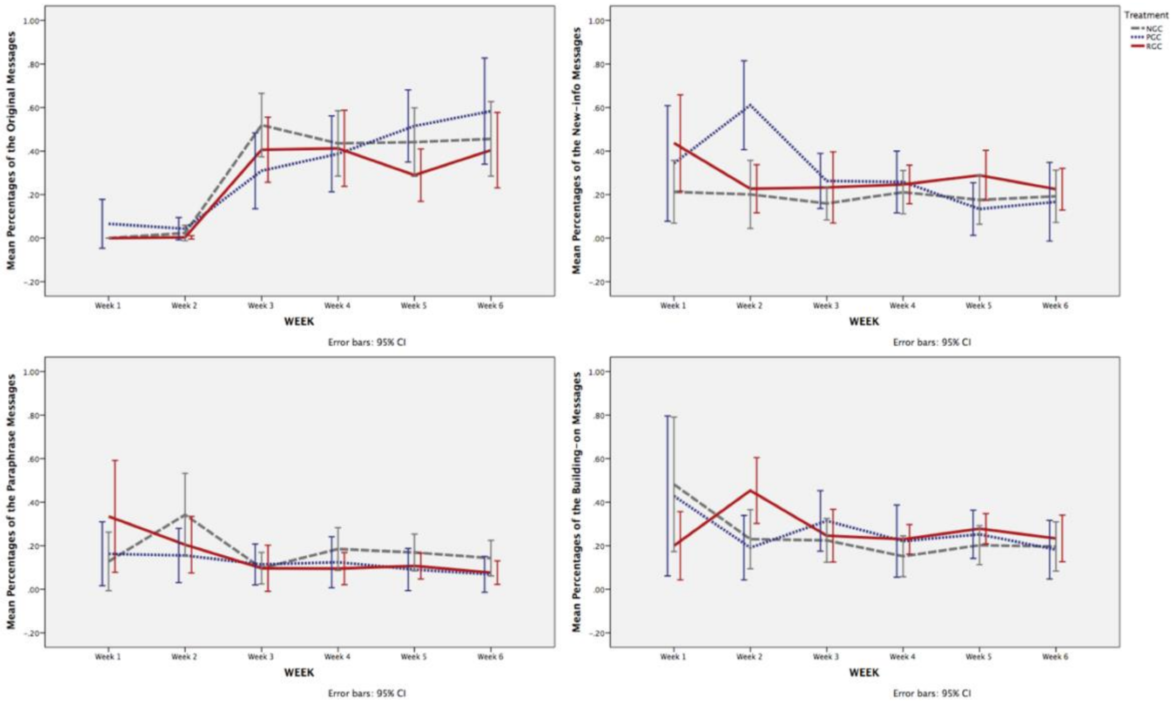

Figure 12 *The Average Percentage of Each Type of Messages in Each Week in the Three Versions of the Course (Left top: Initial Response; Left bottom: Paraphrase Response; Right top: New-info Response; Right bottom: Building-on Response)*

The weekly pattern of each message type. In this section, I compare the weekly changes of each response type that students posted in the three versions of the course. Figure 12 presents the changes of the responses posted by students in the courses in each week. The proportions of each response type in the last four weeks changed less in all the three versions of the course. Students posted Initial responses more often and Paraphrase responses less often. In the first two weeks, the proportions of the Initial responses presented in Figure 12 were lower in all three versions of the course. This is because this type of response was usually sent to the facilitator (who initiated the discussion questions), and in the first two weeks, the facilitator was the instructor rather than peers.

Initial responses weekly changes in the courses. Using the percentage of the Initial responses posted by the students as the dependent variable, and week and the dummy codes of the course versions as independent variables, a multiple regression was conducted. The model explained 21.4% of the variances of the Initial response percentages, $F(3, 242) = 23.221$, $p < 0.001$. Week showed a positive influence on the percentage ($B = 0.091$, $p < 0.001$), which indicated students were more likely to send the Initial responses to peers as time went by. The regression coefficient of the two dummy variables showed there were no statistically significant differences of the Initial responses percentage found between the two gamification versions of the course. However, the Initial responses percentage significantly differed in-between the NGC and the PGC. The percentages of the initial responses were higher in the NGC ($B = 0.088$, $p < 0.05$). The interaction items of the dummy variables and the week were added to the regression; however, there was no significant change found in the value of R square, *F Change* (2, 240) = 0.577, $p = 0.563$. Therefore, the effect of week on the percentage of Initial response was not moderated by the version of the course.

Table 32 *Multiple Regression Analysis Summary Explaining the Percentage of the Initial Response in the Week From Gamification Condition, and Week, and Sequential Multiple Regression Model Summary (N=246)*

	B	Std. Error	Beta	95.0% Confidence Interval for B	
				Lower Bound	Upper Bound
(Constant)	-0.063	0.053		-0.167	0.041
WEEK	0.091	0.012	0.45***	0.069	0.114
Original	0.088	0.044	0.133*	0.001	0.174
Prototype	0.056	0.049	0.076	-0.041	0.153

Note. R Square = 0.224 F(3,242)=23.221 p<0.001
*p<0.05; ** p<0.01; *** p<0.001

***Paraphrase responses weekly changes in the courses*.** A multiple regression was used to detect the influence of the course version and the week's influence on the percentage of Paraphrase responses. The model explained 3% of variation of the dependent variable, $F(3, 242) = 3.538$ $p < 0.05$. Week presented a significant negative influence on the Paraphrase response percentages ($B = -0.025$, $p < 0.01$); however, the value of the coefficient was smaller with the consideration of the average number of messages that students posted in total. The coefficients of the two dummy variables showed that the Paraphrase response percentage in each week was not significantly different between the NGC and the RGC, and between the PGC and the RGC. Additionally, the adding of the interaction items of the dummy variables and week caused no significant differences in the model, *F Change* $(2, 240) = 1.605$, $p = 0.203$; therefore, the negative influences of week on the percentage of Paraphrase responses were not moderated by the version of the course. Students posted less and less Paraphrase responses in the semester.

Table 33 *Multiple Regression Analysis Summary Explaining the Percentage of the Paraphrase Response in the Week From Gamification Condition, and Week, and Sequential Multiple Regression Model Summary (N=246)*

	B	Std. Error	Beta	95.0% Confidence Interval for B	
				Lower Bound	Upper Bound
Constant	0.236	0.037		0.163	0.308
WEEK	-0.025	0.008	-0.193**	-0.04	-0.009
Original	0.024	0.031	0.059	-0.036	0.085
Prototype	-0.012	0.034	-0.026	-0.08	0.056

Note. R Square = 0.042 F(3,242)=3.538 p<0.05
*p<0.05; ** p<0.01; *** p<0.001

***New-info responses weekly changes in the courses*.** By using the percentages of the

New-info responses as dependent variable, and the week and the two dummy variables of the gamification versions as the independent variables, a regression model was conducted to compare students' postings of the New-info responses. The model explained 5.3% of the variation of the dependent variable, $F(3, 242) = 5.346$ $p<0.01$. There was a significant difference in the percentage of the New-info response between the NGC and the RGC.

Moreover, the interaction items of the dummy variables and the week variable were added in the model, and they caused a significant change in R square, *F change* $(2, 240) = 3.484$ $p < 0.05$; the adjusted R square increased to 7.2%.

Table 34 *Sequential Multiple Regression Analysis Summary Explaining the Percentage of the New-info Response in the Week From Gamification Condition, Week, and Interaction Items of the Gamification Condition and Week, and Sequential Multiple Regression Model Summary (N=246)*

	B	SE	Beta	95.0% Confidence Interval for B		R^2	ΔR^2
				Lower Bound	Upper Bound		
Step 1						0.065	0.065
Constant	0.364	0.043		0.28	0.448		
WEEK	-0.026	0.009	-0.175**	-0.045	-0.008		
Original	-0.078	0.035	-0.162*	-0.148	-0.008		
Prototype	0.014	0.04	0.026	-0.064	0.092		
Step 2						0.091	0.026
Constant	0.352	0.062		0.229	0.475		
WEEK	-0.023	0.016	-0.153	-0.054	0.009		
Original	-0.151	0.086	-0.313	-0.322	0.019		
Prototype	0.173	0.097	0.317	-0.019	0.364		
Original by Week	0.019	0.022	0.17	-0.024	0.061		
Prototype by Week	-0.042	0.024	-0.326	-0.089	0.006		

Note. Step1, R Square = 0.065 F(3,242)=5.605 p<0.01
Step2, R Square = 0.091 F(3,242)=4.826 p<0.001
*p<0.05; ** p<0.01; *** p<0.001

To further analyze how each version of the course moderated the effect of week on the percentage of New-info responses, the regression model with percentage of New-info responses as DV and Week as IV was conducted separately for each version of the course. The results are shown in Table 33. Week did have a negative influence on the percentage of the New-info response in each version of the course; however, only the model of the PGC had a significant R square and a significant coefficient of week. Therefore, it showed that in the NGC and RGC, week did not significantly negatively influence the percentage of New-info responses; however, in the PGC, the percentage of New-info response did decrease significantly by week.

Table 35 *Multiple Regression Analysis Summaries for the Percentage of New-info Responses in the Week from Week, in The Three Versions of the Courses*

	NGC (N=112)		PGC (N=60)		RGC (N=74)	
Variable	B	R_2	B	R_2	B	R_2
Constant	0.196**	0.0001	0.553***	0.192***	0.352***	0.031
	(0.059)		(0.08)		(0.059)	
WEEK	-0.002		-0.072***		-0.023	
	(0.014)		(0.02)		(0.015)	

*p<0.05; ** p<0.01; *** p<0.001

Building-on Responses**.** A regression model was used to examine the influences of week and course version on the percentage of Building-on responses. The model explained a total 3.9% of variation of the dependent variable, F (3,242) = 3.308, p < 0.05. Week showed a significant negative influence on the percentage of Building-on responses, indicating the percentage of Building-on responses decreased as time went by. Also, though students in the RGC had higher percentages of the Building-on responses, the differences between the RGC and NGC, and between RGC and PGC, were not significant. The interaction items of week and the dummy variables of course version were added in the model and caused no significant change in the R square *F change* (2, 240) = 0.444, p = 0.642. Therefore, the course version did not moderate week's negative effect on the percentage of Building-on responses.

Table 36 *Multiple Regression Analysis Summary Explaining the Percentage of the Building-on Response in the Week from Gamification Condition, and Week, and Sequential Multiple Regression Model Summary (N=246)*

	B	Std. Error	Beta	95.0% Confidence Interval for B	
				Lower Bound	Upper Bound
(Constant)	0.365	0.042		0.163	0.308
WEEK	-0.025	0.009	-0.193**	-0.04	-0.009
Original	-0.044	0.035	0.059	-0.036	0.085
Prototype	-0.021	0.039	-0.026	-0.08	0.056

Note. R Square = 0.039 F(3,242)=3.308 p<0.05

*p<0.05; ** p<0.01; *** p<0.001

The Group Level Interaction Weekly Pattern. The regression analysis showed that the difference of the messages that students posted weekly was similar in each week, but it did change week to week. In this section, I describe the weekly class-level interaction patterns in the three versions of the course.

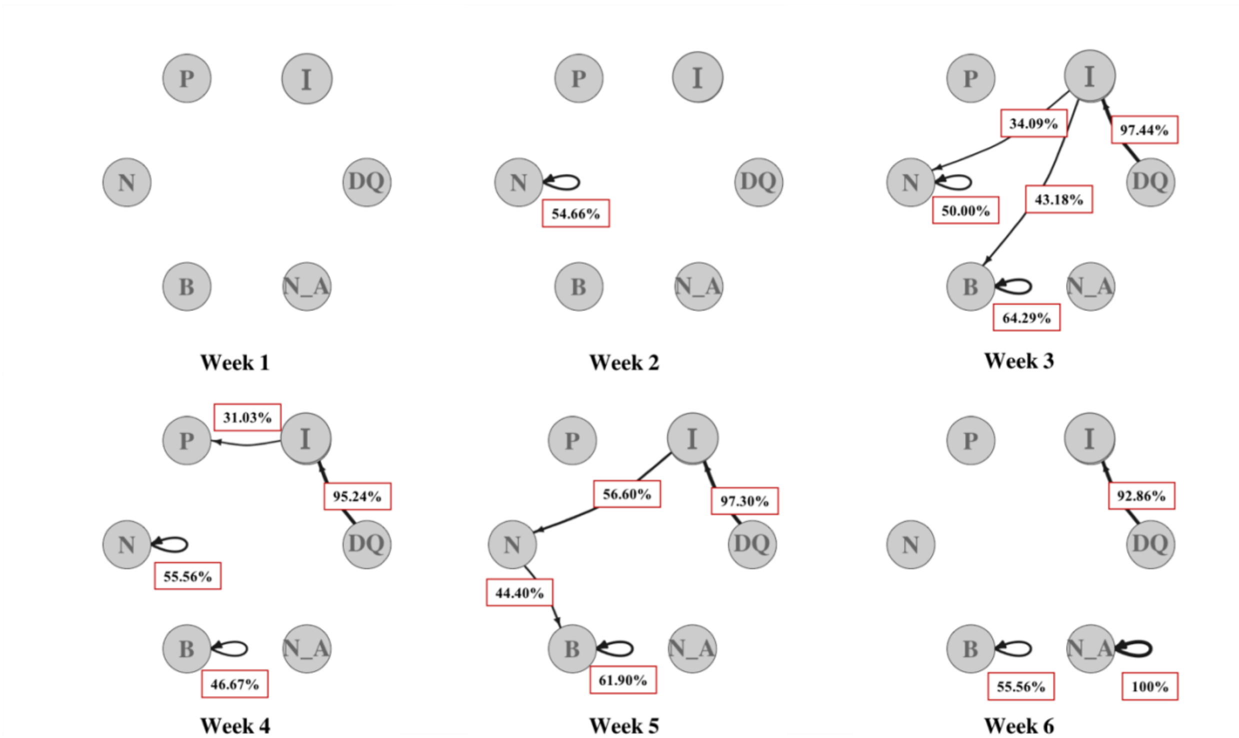

Figure 13 *The Transitional Diagram of Each Week in the Revised Gamification Course. All the significant two-response chains and the chains occurred more than 5 times in total were in the diagram and were added annotation with the transitional probability.*

Figure 13 presents the transition diagram of each week in the RGC. In the first two weeks, the instructor was the discussion facilitator, and there was only one significant two-response chains (the N-loop) in week 2 in students' interaction. Overall in the six weeks, besides the DQ->I chain, the most frequent response chains were the loop of New-info responses and the Building-on responses. This indicated that students actively contributed to the discussion by either adding new information or advancing each other's ideas in each week. Furthermore, once the conversation reached to the higher levels, it was more possible to be continued by students.

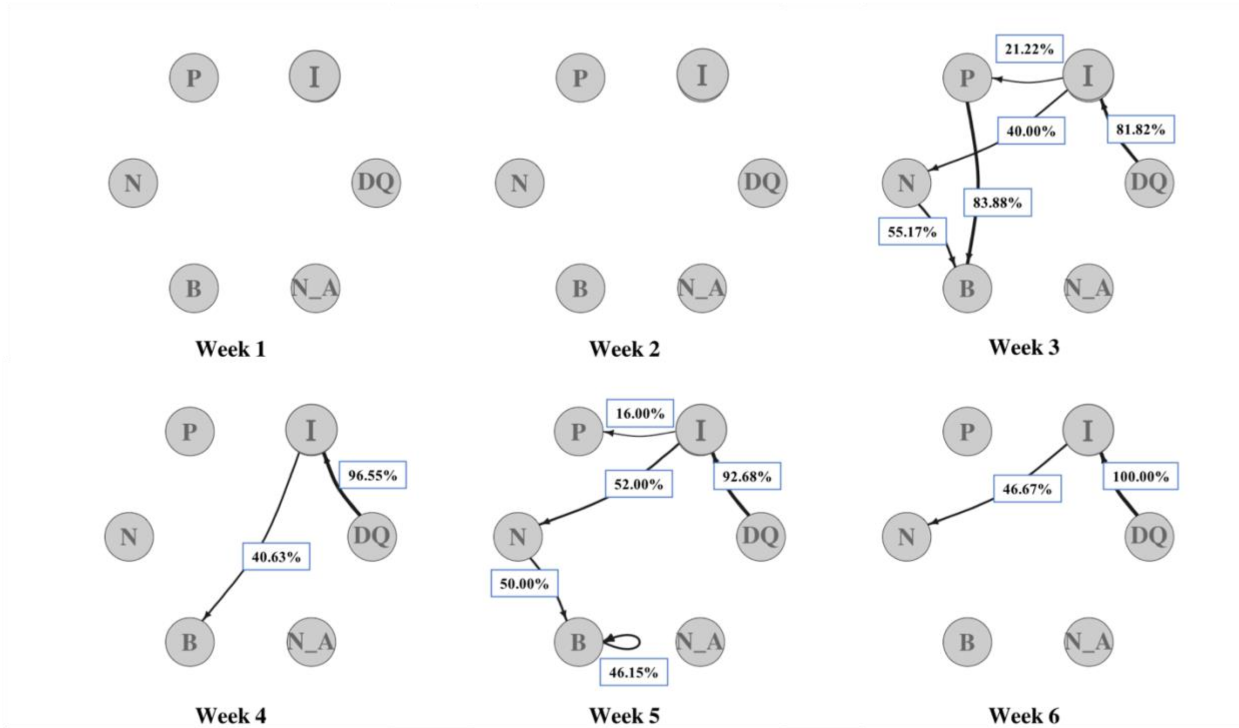

Figure 14 *The Transitional Diagram of Each Week in the Prototype Gamification Course. All the significant two-response chains and the chains occurred more than 5 times in total were in the diagram and were added annotation with the transitional probability.*

Figure 14 shows the transition diagram for the class-level interaction in the PGC; there were no significant two-response chains in the first two weeks of students' interaction. In the last 4 weeks, besides the B-loop in week 5, the other significant response chains were all pointing to the higher level of responses in terms of knowledge building. This indicated a different class-level interaction pattern in comparison with the RGC. In the PGC, students' interaction also moved the discussion forward by adding new info and building on Initial responses. But compared to RGC, there were fewer continuing conversations in the New-info and Building-on categories. This indicated that it was possible there were more unfinished discussions or unanswered questions in the PGC.

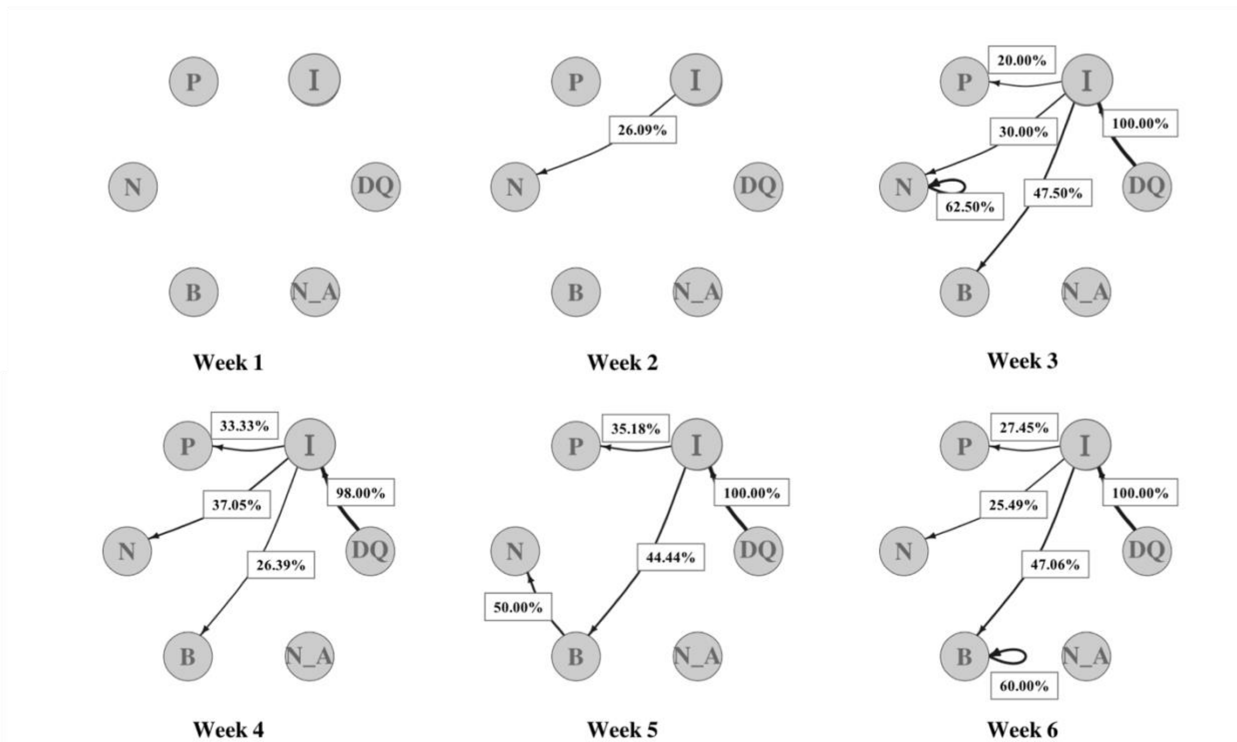

Figure 15 *The Transitional Diagram of Each Week in the Non-Gamification Course. All the significant two-response chains and the chains occurred more than 5 times in total were in the diagram and were added annotation with the transitional probability.*

Figure 15 displays the transition diagram for the group-level interactions in the NGC in each week. In the first two weeks, there was fewer students' interaction, resulting in limited significant two-response chains. The significant chains in the last four weeks were more similar, as in the PGC; there was only one N-loop in week 3 and one B-loop in week 6. Additionally, the I->P chain was significant in all four weeks, which was a different pattern from PGC and RGC. These significant I->P chains indicated a 1/5 to 1/3 chance that students' initial responses were followed by a Paraphrase response without adding any new information or development.

Comparing the weekly group-level interaction patterns in the three versions of the course, it presented different group-level interaction features. In the NGC, the Initial responses had been followed by Paraphrase, New-info and Building-on responses, but there were limited N-loop and

B-loop. In the PGC, there was fewer N-loops, B-loops, and fewer I->P chains compared to the NGC. In the RGC, there were more N-loops and the B-loops in each week. The NGC students actively replied to the Initial responses. Compared to the gamification versions students, the replies to the Initial responses in the NGC had a higher chance to be Paraphrase response. Furthermore, in the NGC and PGC, there were greater chances that the discussion or follow-up questions were not concluded properly. Nonetheless, the RGC had more N-loops and B-loops indicating that the discussion had been carried on by students with higher-level interaction responses. Therefore, there were fewer chances that the discussion and the fellow-up questions had been left open in the RGC.

Interaction Quality Comparison Summary. In this section, I analyze students' interaction at both the semester scale and week scale. The gamification design's impact on students' interaction was complex. Overall, on a semester scale, the messages posted by the gamification versions' students had more New-info responses and Building-on responses. However, on the semester scale, the significant differences were only between the RGC and NGC. The RGC students posted fewer Initial responses and more New-info responses. Then I examined the group-level interaction pattern in terms of knowledge building. On both the semester and week scales, the RGC had significant N-loops and B-loops, indicating there was a larger chance that the New-info responses were followed by another New-info responses (e.g., a follow-up question had been answered), and the Building-on responses were more likely to be followed by Building-on responses (e.g., a negotiated message was sent to a new statement). Therefore, students tended to leave few unsettled arguments or unanswered questions in the RGC. This could be due to the regular participation bonus in RGC, which awarded students' behaviors of coming back to the discussion regularly in each week. Even though the B-loop and the N-loop were also significant in the NGC at the semester scale, they were not significant in most weeks in the NGC. In conclusion, the RGC students were more likely to build on each other's statement and add new information in the discussion forums.

Interaction Comparison Summary

In this section, I compare students' interaction in the three versions of the course from three aspects: quantity, interaction dynamic, and interaction quality. Students in the RGC posted significantly more messages in the discussion forums than students in the NGC on both semester and weekly scales. The differences in the number of messages were not significantly different between the two gamification versions of the course. Particularly, students in the gamification versions of the course more actively participated in the discussion when they were the facilitator of their threads.

For the interaction dynamic, the connection among the gamification versions of students was more even. First, there was a significant difference in the in-degree between the RGC and NGC in both the semester and weekly scales, meaning that on average, the RGC students received comments from a broader range of classmates. The differences of the two gamification versions of the course were not statistically significant. Second, the significant higher ratio of dyads in the RGC indicated that students were more likely to receive a reply after they posted in the discussion forum. The out-degree comparison results echoed this finding. The out-degree in the three courses was about the same in both the semester and weekly scales, indicating that a student sent messages to a similar amount of peers, while the higher number of messages posted in the RGC indicated more turns of conversation between the same pair of students. Finally, the higher density scores and the lower centralization scores in the RGC meant the dense connections in the RGC were because the most students "talked" to the most students rather than a small group of students interacting with everyone else. This decentralized interaction pattern observed in the gamification versions of the course could be due to the discussion forum-related badges which reminded students to interact with different peers in a discussion thread.

Gamification design also showed impacts on the interaction quality. From a knowledge building perspective, students in the gamification versions presented more knowledge building behaviors by posting more responses that either added new information or advanced the existing statement in the discussion forum. The results from LSA showed that though the discussion kept developing by students in all the three versions of the course, students in the RGC were more likely to leave fewer unanswered questions and unfinished discussions. Additionally, RGC students also had more discussions leading to non-academic responses. This class interaction pattern observed in the RGC could be due to the best speech badges and the regular participation bonus experience points.

Overall, the students' interactions were significantly different between the RGC and NGC in terms of quantity, interaction dynamic, and interaction quality. The differences between the RGC and PGC were not significant. Therefore, the gamification design had positive impact on students' interaction in the academic discussion forums in the online course. The next section in this chapter explains how the gamification worked and students' perspective of the revised gamification design.

Students' Gamification Participation in the Two Gamified Courses

Based on the comparison of students' interaction in the three versions of the course, there was no significant difference between the two gamification versions of the course, except for the class level interaction pattern. Students' participation in the various gamification activities could reveal students' reaction to the gamification design elements, which helped to understand to what degree students were engaged in the various gamification activities and which gamification design elements were related to the differences of the class-level interaction pattern between the two gamification versions' designs. This section presents students' participation data in the two gamified courses, the PGC and the RGC.

Experience points

The experience points were documented and calculated in an Excel file. Students' participation data including posting in the discussion forum and the class notebook (wiki) were from Blackboard log data. The experience points were updated twice a week on Thursday (Th) and Monday (M), posting on the leaderboard and the personal page. All the students started from zero experience points.

The two pie charts in Figure 16 display the total experience points by categories in the two gamification versions of the courses. The major source of the experience points was from posting in the discussion forum. The second major source of the experience points was difference. In the RGC, it was the bonus experience points, and in the PGC it was the contribution to the class readings. The other major difference was the experience points earned from sharing reading notes—the RGC students earned three times more than the PGC students earned. Next, I compare the experience points' growth pattern in the two gamification versions of the course.

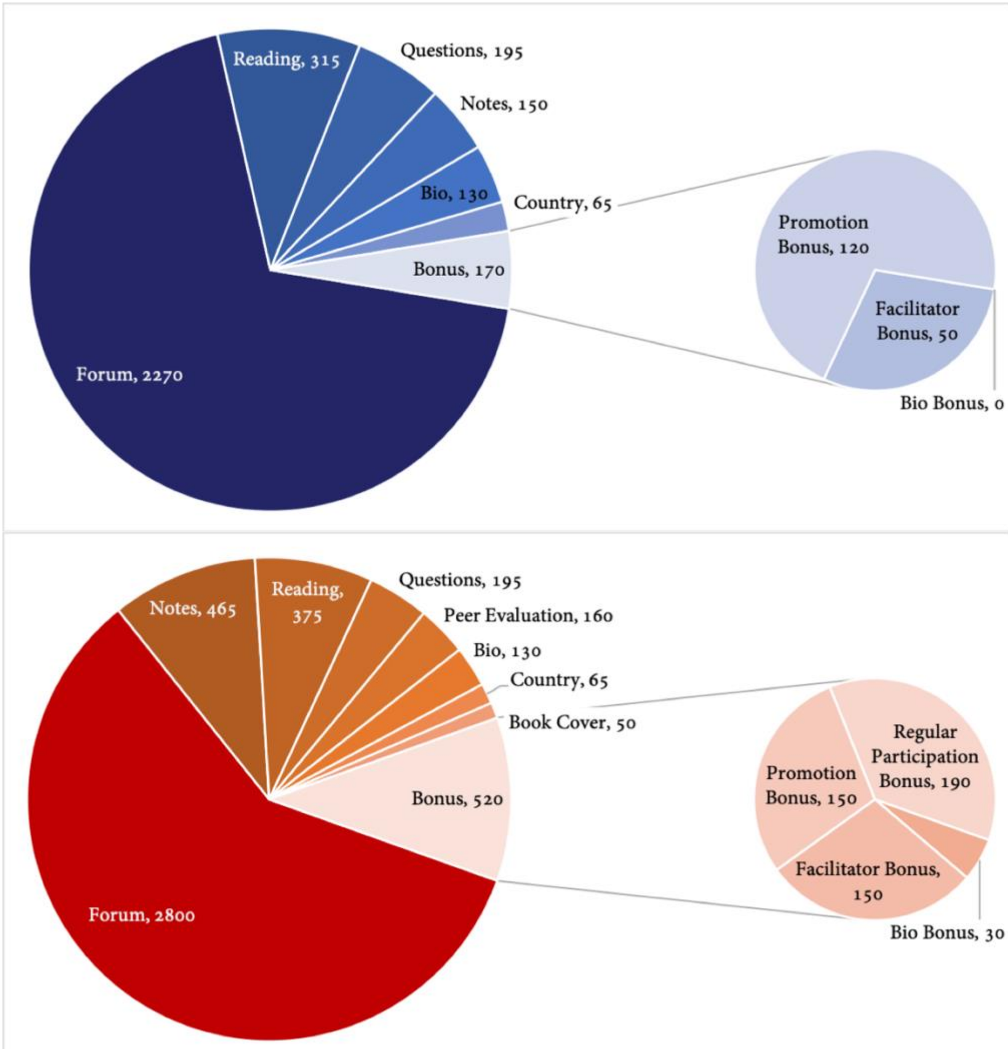

Figure 16 *Experience Points Broken Down, The figure on the top was the PGC, the figure on the bottom was the RGC. The number was the total experience points earned in the category by all the students in the course.*

As shown in Figure 17, in each update timepoint, the average experience points in the RGC was higher than the PGC. The RGC students won more experiences points. In the RGC, I added several activities that attached experience points, such as participating in the peer evaluation, voting for the book cover, and the regular participation bonus. The higher mean experience points indicated that the RGC students were proactive in these new gamification activities. Figure 16 also displays two different increasing patterns in the two gamified courses.

The increasing of the experience points slowed down in the last four updates in the PGC. This pattern was not observed in the RGC, meaning that students kept their activity level towards the end of the course. When students earned more than 310 experience points, they could receive the full participation score in the final grade. Therefore, even though in the RGC several students earned more than 310 experience points in the last week, they still kept participating in the gamification activities. This could be due to the leaderboard; students who were in the leading position were determined to stay on the top, thus they kept participating in the activities even though they had earned the full participation points in the final grade.

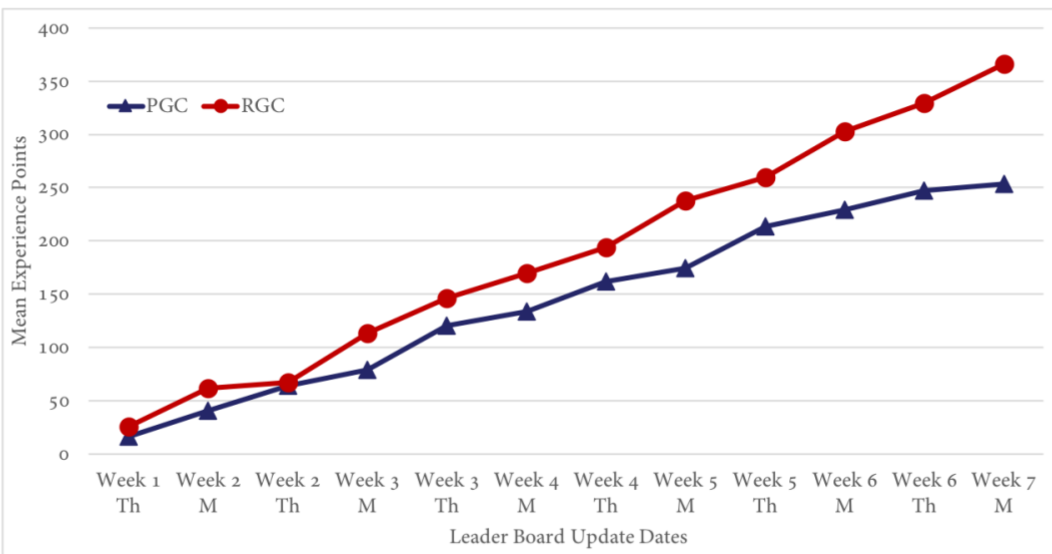

Figure 17 *The Average Experience Points in Each Update in the Two Gamified Courses*

From the descriptive data of the experience points in Table 37, it was notable that the standard deviations were larger and larger as time went by in both courses. This was due to the different active levels of students—the gaps between the experience points among students were larger towards the end of the course. It was possible that students who had higher experience points earlier felt more rewarded, thus maintaining the fashion of earning as most experience points as they could in each week. Moreover, the medians and the minimum experience points were larger in the RGC except two cases. This indicated that the less active students in the RGC participated in more gamification activities than the less active students in the PGC.

Table 37 *Descriptive Statistics for the Experience Points in each week's two updates (Th is Thursday and M is Monday)*

	PGC (N=13)					RGC (N=13)				
	Mean	SD	Median	Min	Max	Mean	SD	Median	Min	Max
Week 1 Th	16.54	12.972	25	0	30	25.77	8.861	25	15	40
Week 2 M	40.38	24.364	40	0	80	61.92	26.5	55	30	105
Week 2 Th	63.85	43.357	45	20	140	67.31	32.635	55	30	130
Week 3 M	79.23	46.986	80	20	145	113.08	43.995	120	55	180
Week 3 Th	120.38	75.566	105	20	250	146.54	67.218	135	55	240
Week 4 M	133.46	72.266	130	20	255	169.62	66.127	150	65	260
Week 4 Th	161.92	71.75	145	20	270	194.23	90.918	170	65	355
Week 5 M	174.23	69.936	165	45	275	237.69	110.503	225	85	445
Week 5 Th	213.85	95.025	250	45	340	260	103.3	245	85	460
Week 6 M	229.62	97.926	275	90	345	303.08	121.972	285	85	535
Week 6 Th	247.31	92.367	285	95	360	329.23	127.636	310	125	580
Week 7 M	253.46	93.439	285	95	360	366.15	138.69	335	165	625

Posting in the discussion forum. Figure 18 shows the average experience points earned by students and the experiences points from posting in the discussion forums in each week in the PGC and RGC. Students won their experience points mostly by participating in the online discussion. The earned experience points were fewer in the first and the last week in the PGC, but this posting pattern did not present in the RGC.

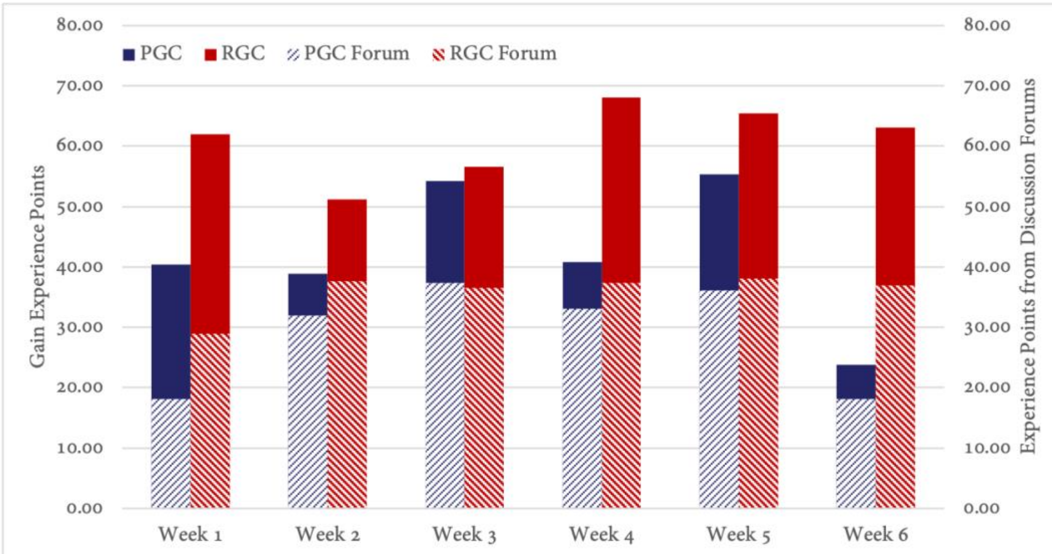

Figure 18 *The Experience Points Gained in Total and Gained From Posting Messages in the Discussion Forums in Each Week in the Two Versions of The Course.*

Individual facilitator. In both the RGC and PGC, all students participated in the individual facilitator activity. A larger proportion of RGC students created two threads in their facilitation week. Specifically, nine out of 13 RGC students created two threads in their weeks, while one student out of 13 PGC students created two threads.

All the students contributed the reading materials to the class library. In the RGC, except one student who only shared one reading material, and one student who shared three reading materials, all the other students shared two reading articles. In the PGC, there were five students who shared only one reading, while all the others shared two readings.

Sharing reading notes in the class notebook. In the RGC, one design adjustment was made in the Class Notebook activity. Students could create new pages in each week to put their notes, while in the PGC, students needed to put notes for each reading in one designated page created by me. As shown in Figure 19, the sharing notes contributed to a small portion of experience points in each week in both gamified courses. However, more RGC students participated in the activity at least once.

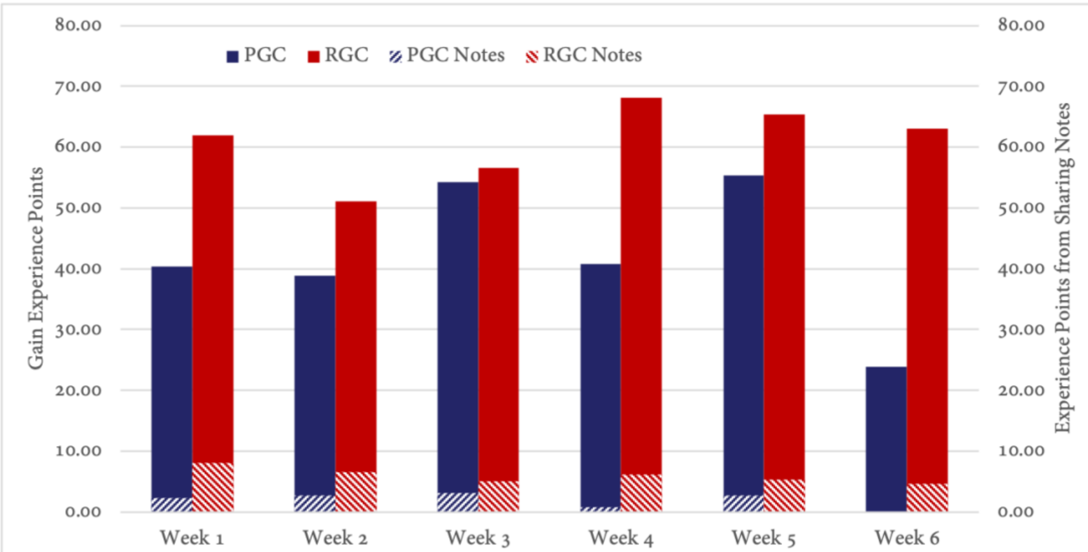

Figure 19 *The Experience Points Gained in Total and Gained from Posting Notes in the Class Notebook in Each Week in the Two Versions of the Course.*

Specifically, 11 RGC students participated in the notebook sharing activity. In week 2, both the number of notes shared and the number of contributors reached the peak (Figure 20). Though the number of contributors decreased in the following weeks, the number of notes was similar to week 1's. In the PGC, six students participated in the activity. During the six weeks, fewer and fewer students shared their notes. In the last week, none of the students shared any reading notes in the class notebook.

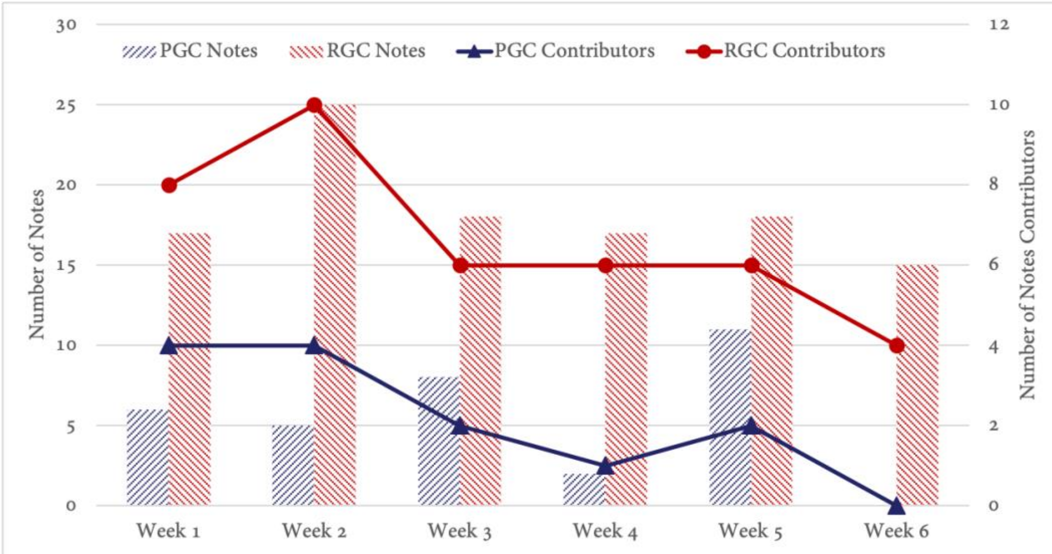

Figure 20 *The Number of Notes Posted and The Number of Notes Contributors in the Two Gamification Versions of The Course*

Did students prefer to participate in the discussion forum rather than the notebooks? The answer was no. The PGC students who did share their reading notes frequently in the class notebook were also active in the discussion forums. Therefore, it was not a personal choice, but the inactive students being reluctant to participate in both the discussion forum and the class notebook. Similarly as the PGC, the RGC students who were in the upper part of the leaderboard posted more regularly in the class notebook. However, there were also students in the bottom part of the leaderboard who shared their notes in multiple weeks.

Peer evaluation. On each Friday, a peer evaluation survey was sent out to students to collect their opinions on the best messages posted on the discussion forums in the week. Students could earn five experience points by submitting their nomination of the best message in the week. Overall, 11 out of 13 students participated in at least one peer evaluation activity in the RGC. Four students participated in the survey in the first two weeks; however, there were two students who participated in the survey in week 3. Therefore, from week 4 on, in the email that included the survey link, students were reminded of the experience points they could earn. Seven students participated in the week 4 and week 6 peer evaluations, and eight students participated in the week 5 peer evaluation.

Bonus experience points activities. In the RGC, six students shared a video format self-introduction video and won the bonus points. In the PGC, none of the students posted a self-introduction video. For the facilitation bonus, three student facilitators won the bonus in two weeks, separately, while there was only one student who eventually earned the facilitation points in the PGC. For the two promotion bonuses, eight students won the intern bonus, and seven students won the junior specialist bonus in the RGC. The two numbers in the PGC were seven and five. This indicated that there were more active students in the RGC.

Since week 3, I added new bonus points to encourage regular participation in the discussion forums. Students who participated in one discussion thread in three different days within a week could win five extra points. For each week, they could win at most 15 points in this category. Six students won these bonus points in week 3, five students won it in week 4, seven students won it at week 5, while only three students won this bonus in week 6. This echoed the findings in the interaction comparison. The average number of messages posted in the last week did not significantly decrease compared to the previous weeks, but the class level interaction patterns were different; there were fewer significant two-response chains (as seen in Figure 13).

Badge

There were five badges in the two versions of the gamification course. Three badges were designed for the discussion forums, and the other two were designed for the written assignments that were part of the book chapters. Figure 21 presents the total number of each type of badge issued and the number of badge winners. In the PGC, 20 in-degree badges (the incentive badges) were issued to nine students, and 18 out-degree badges (the resourceful badges) were issued to six students. Four peer evaluation badges (the best speech) were issued to four students in the third and fifth weeks only. Overall, there were only two students who never received a badge, and four students who never received any discussion forum related badges.

In the RGC, 24 in-degree badges (the inspiring badge) were issued to ten students, and 20 out-degree badges (the resourceful badges) were issued to six students. 19 best speech badges were issued to eight students. Overall, there was only one student who never received a badge, and three students who never won any discussion forum related badges.

Comparing the RGC with the PGC, the winner coverage of the out-degree badges were both smaller, indicating that about half of the class always commented to peers more actively than the other half. The redesign of the speech badge worked well in the RGC in terms of the coverage of the badge and the participation rate of the peer evaluation activity.

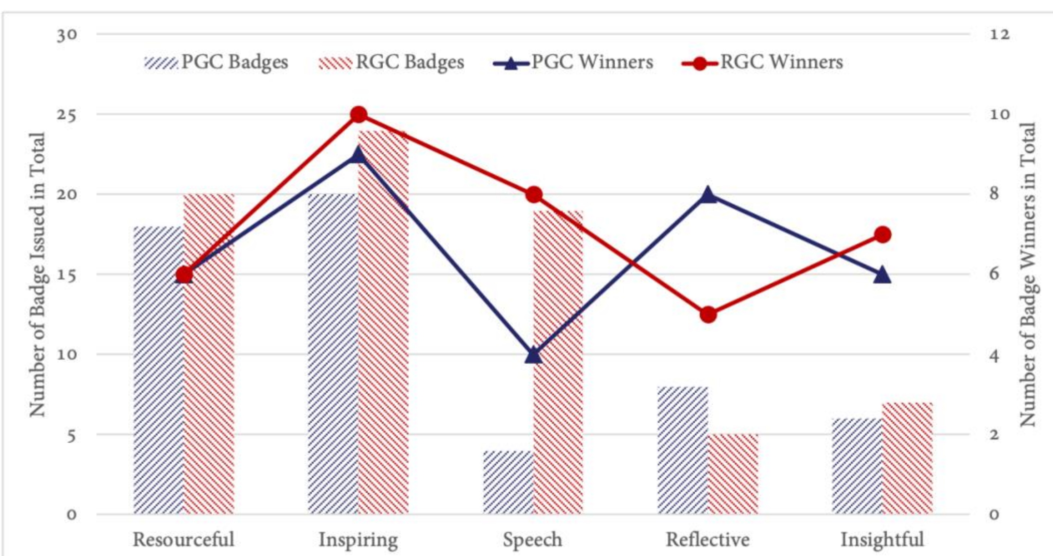

Figure 21 *The Number of Badges Issued in Total, and the Number of Badge Winners in Total in the Two Gamification Version of the Course*

Leaderboard and Personal Page

Figure 22 and 23 below present the pattern of the click stream data of the leaderboard and the personal page section on Blackboard. Due to a technical issue, the clicking data of the third week's update and the fourth week's first update in the PGC were lost. In Figure 21 the bar represents the average click by students, and the line represents the median.

The available data showed that students in the PGC clicked the leaderboard more often on the update days over the six weeks. Based on the median values of each week, in some weeks, more students checked the leaderboard in the RGC; however, fewer students clicked multiple times of the leaderboard, which resulted in the lower means for the RGC.

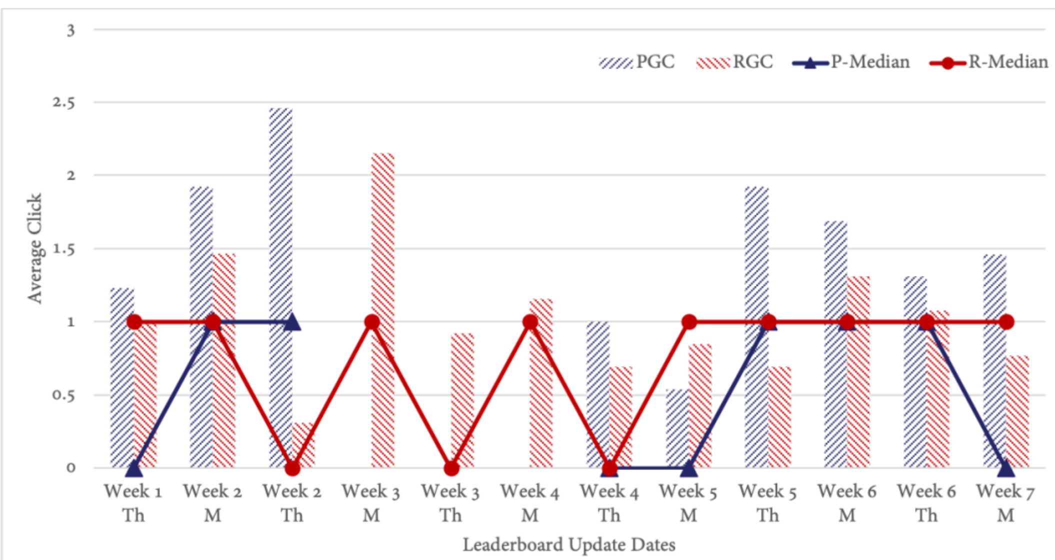

Figure 22 *The Mean and Median of the Click on the Leaderboard on Each Update Date in the Two Gamification Versions of The Course*

Fewer students checked the personal page on the update days. The means were less than the leaderboard click data. As shown by the median, in most weeks, more than half of the students did not check the personal page on the update dates.

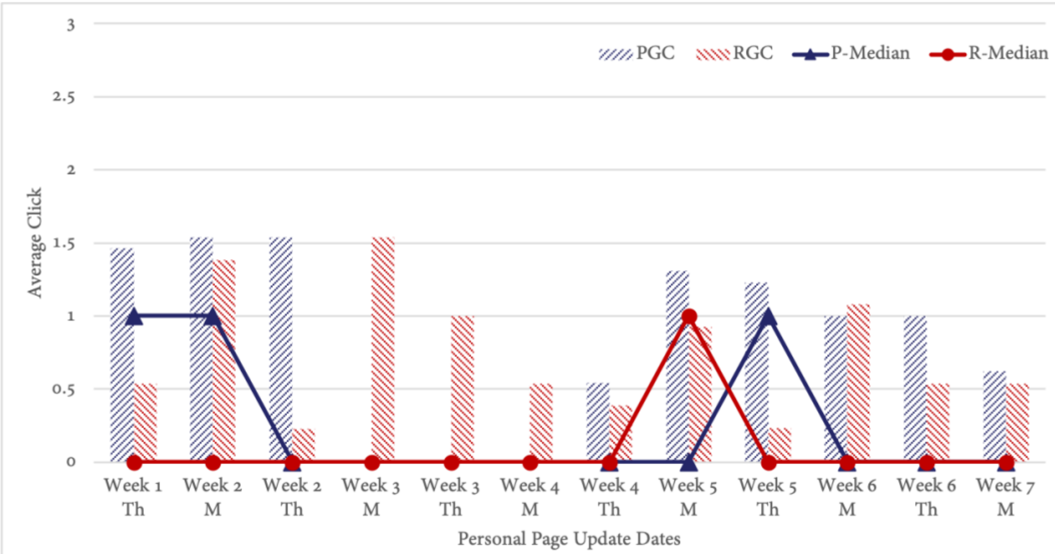

Figure 23 *The Mean and Median of the Click on the Personal Page on Each Update Date in the Two Gamification Versions of the Course*

The Level System

In the PGC, seven out of 13 students reached the intern level on the first update day (the Thursday of week 1). By the end of the first week, only one student still remained at the beginning level. Four students reached the junior level in the second week. Three students reached the senior level in the fifth week, which was the highest level in the promotion track. At the end of the course, five students reached the senior level. The other eight students reached the second highest level: the junior level. Even though the experience points needed for the junior level could be reached by the end of the second week as long as students met the minimum posting requirement in the non-gamification course, eight students did not reach the requirement. Similarly, students who reached the minimum requirement in the non-gamification course should have reached the senior level by the end of week 5, however, only five students made it.

In the RGC, eight out of 13 students reached the intern level on the first leaderboard update. By the end of the first week all the students reached the intern level, and two students already reached the junior specialist level. Seven students reached the junior level by the end of week 2. One student reached the senior level in the 4th week, which was one week earlier than students in the PGC. Finally, at the end of the semester, nine students reached the senior level, while in the PGC, the number was five. Also, it was noticeable that in PGC, there were no changes in the latter half of the sixth week of students' final rank. But in the RGC, four more students earned the senior level title. Additionally, it should be mentioned that there was one junior specialist who was only five points away from receiving the senior specialist title. The other three junior level students' experience points were higher than their counterparts in PGC.

Gamification Participation Summary

The revised gamification design had kept the majority of gamification elements in the prototype gamification design. Several design adjustments had been made based on the analysis of students' performance in the PGC. The gamification performance data showed that most RGC students actively participated in various gamification activities; the average experience points and the final ranks was both higher than the PGC students. More RGC students participated in the notes sharing and peer evaluation activity. On each updated date, students in both courses checked the leaderboard more often than the personal page. Additionally, students' interests in the gamification were different.

The descriptive data presented above gave a general picture of students' participation in the course activities and their reactions to the gamification settings. Even though there were limited significant differences of students' interaction found between the two gamified courses, the design adjustments did improve students' gamification participation. The RGC students could win experience points from more activities; however, their participation in the discussion forum did not decrease compared to the students in the PGC. More importantly, the sharp last week decrease in the PGC was not observed in the RGC.

Finally, the different class level interaction pattern could be due to the regular participation bonus points, which encouraged students to participate in a discussion thread at least three times a week to check the replies and make comments. Additionally, in the RGC, Blackboard added a new feature in the discussion forum, where students could see the number of unread replies they got in the discussion forum. This feature with the regular participation could have helped reduce the chances of unanswered follow-up questions and unconcluded discussion. In the next section, I present students' experiences and perceptions of the gamification design elements in the RGC, which could also help to understand the patterns of students' interaction in the discussion forums.

Students' Experiences and Perception in the RGC

The previous sections in this chapter compared students' interaction measured by quantity, interactivity, and quality in the three versions of the course, then presented the gamification activity performance in the two gamification versions of the course. This section provided a qualitative insight of students' interaction in the revised gamification course. This part focuses on addressing the third research question: How does gamification design influence students' performance in the online discussion forum in terms of the quantity, interaction dynamic, and the quality of interaction? In this part, I first present students' perspectives on each gamification element, then discuss the relationship of the gamification design and students' needs satisfaction.

Nine students agreed to be interviewed after the course. Eight of them finished the interview. Five students chose a face-to-face interview, and one student chose a video conferencing interview, but due to technical reasons, she chose a face-to-face interview eventually. Due to their busy working schedule, the other two students chose an email interview. One student finished the interview via writing format; the other student recorded the response to the interview questions and used Otter to transcribe his recording, then sent both the audio and transcript in the Otter webpage back. For the eight students who finished the interview, a $15 Amazon Gift Card was sent to them to compensate their time.

The seven interviewees were at the upper half of the leaderboard ranking from the first to the seventh, and one interviewee was in the bottom half of the leaderboard, ranking at thirteenth. Their gamification performance is presented in Table 38. Table 39 provides the descriptive statistics for the eight interviewees and all the RGC students. The interviewees had higher average experience points compared to the whole class group. Moreover, they won the most badges in the class. The top performers in the class participated in the semi-structured interviews.

Table 38 *Gamification Performance of each interviewee*

Interviewee	Rank	Level	Experience Points	Badges	
Student 41	5	Senior	365	8	Face-to-face
Student 42	3	Senior	550	14	Face-to-face
Student 44	6	Senior	340	3	Face-to-face
Student 45	4	Senior	370	8	Face-to-face
Student 46	2	Senior	565	12	Face-to-face
Student 47	12	Junior	185	4	Self-recording
Student 48	7	Senior	330	2	Email
Student 49	1	Senior	615	16	Face-to-face

Table 39 *The Descriptive Statistics of the Experience Points and the Number of Badges for the Interviewees and all the RGC students*

	Experience Points				
	Mean	SD	Median	Min	Max
The RGC Interviewees (*N*=8)	421.86	145.45	375	195	625
All RGC students (*N*=13)	366.15	138.69	335	165	625
	Badges				
	Resourceful	Inspiring	Speech	Reflective	Insightful

The RGC Interviewees (*N*=8)	20	20	17	3	5
All RGC students (*N*=13)	20	24	19	5	7
	Click per person per week*				
	Leaderboard		Personal Page		
	Mean	SD	Mean	SD	
The RGC Interviewees (*N*=48)	3.33	2.68	3.58	3.23	
All RGC students (*N*=78)	2.71	2.87	2.66	3.00	

Note:* week here equals to 6

Experience Points

Experience points were one component of the positive feedback system that was designed to satisfy students' competence needs in order to keep their activity level in the course, including the discussion forum. Additionally, the experience points were related to students' final participation score in the course. In the gamification design, the regular experience points were rewarded to students for participation and the bonus experience points were rewarded to students for extra efforts.

Experience points motivated students' participation. Participants believed that the experience points recorded their efforts in the course. Being able to see the increase of the experience points maintained their activity level in the discussion forum, as posting more messages caused the increase of the experience points.

Particularly, students shared that the facilitator bonus motivated them to think about how to get more replies for their thread. Most interviewees mentioned to reply more frequently to their peers when being the facilitator. Trying to win the facilitator bonus was "fun but also challenging" according to Student 48 (S48). He shared that his strategy to earn the facilitator bonus was to use questions to continue the discussion. S48 also stressed that he tried to not ask "basic questions" by paying attention to the messages that his peers made. Student 41 (S41) shared the similar strategy of "hitting people with questions" in order to follow up on the articles that she carefully selected and had great interest in. Student 49 (S49) shared how she carefully selected the readings and proposed the discussion questions in a way that could motivate their peers to reply:

> I think this part is a way to encourage students to be the facilitator, right? I think we have our time and we can think more ways to lead the discussion. I think, I have never had this experience, so I like this part. [Me: so what did you do?] So I brought a lot of papers and I felt stressful before week two and I talked with you and also Professor A, and both of you give me some suggestions. I think I select the better papers and I know, after this part, I know how to choose the papers, I knew how to write questions, and how to revise questions. I know in real educational settings I know how to encourage students to communicate and discuss with each other, I think this part is my favorite part. (S49, Face to face, 08/14/19)

Student 44 (S44) shared that it was hard to win the facilitator bonus. She also tried to find the materials and questions that could motivate her peers to reply in her thread. That was how she at first tried to win the bonus, but failed eventually. Then she observed how her peers facilitated the discussion and reflected that she should have provided feedback to peers more often.

As in the quantitative findings, the student facilitators of the week posted more messages than others, and the number of messages was also higher than the facilitators in the NGC. From the interviews, it showed that students also used different strategies to encourage their peers to join the discussion. The two main strategies that the interviewees tried included asking follow-up questions that could further the discussion and proposing quality discussion materials and questions. These student facilitators not only posted more messages themselves, but they had also learned and practiced different facilitation strategies in the discussion forums. Therefore, the higher value of the experience points attached to the facilitator task made the challenging nature of the task more explicit to students. Students were willing to take on the task and were proactive in completing the challenge. The higher value of the experience points in this case signified competence information to these students.

Concerns of taking advantages of rewarding participation. Though most students recognized the motivation intention of the experience points, their descriptions of the experience points were different. Some students referred to experience points as a measure of their progress; other students added their concerns about using the experience points to reward quantity in the discussion forum. First, it unsettled some students that the experience points in the gamification design focused on quantity over quality. Student 46 (S46) felt that some messages in this course were more valuable than others. However, the quality of each message was not counted in the experience points. He admitted that this was a common issue in most online courses since it was not feasible for the instructors to grade each message.

Furthermore, two other students shared that how they thought that students could take advantage of the rules. When talking about the facilitator bonus, Student 45 (S45) shared her worries about how this could be misused:

> I guess that one, only because, again, if people are using the game strategies, over the actual learning, I can see how that can be misused. Because people just have more replies, and I guess, and I, that's not me. So I really just did my best to really take it to what people were so I guess those points, didn't necessarily motivated me. Because I want to give good responses, as best I could, you know. I was trying to really be genuine, and I didn't want just give the one

word, just get that number up, that part I didn’t really that wasn’t attractive to me I guess. (S45, Face-to-face, 08/20/18)

In order to win the facilitator bonus, the thread needed to reach at least 45 replies, and, at most, half of the replies could be the facilitator’s. This rule made Student 47 (S47) think it “felt almost fake.” He said he could make the discussion dynamic and engaging with an interesting question to get to the desired number. But he did not believe that could happen:

> But unless I went out and personally texted my friends in the class to say, Hey, could you please reply to this as many times as possible, or reply to it so many times myself, that it would encourage more people to talk, there just wasn't really a reasonable way to get to that number. And so I think that I just gave up, I would rather have just spent that time doing something else or reading about something else than actually trying to make the extra points work on the forum. (S47, self-recording, 03/25/19)

In S47’s case, winning the facilitator bonus was not feasible. The only way he could achieve it was by gaming the game, which he did not think was worth it. Therefore, he gave up and chose to spend time on other learning activities.

Both S45 and S47 mentioned similar strategies, shared by their peers, which could get them to win the experience points: asking meaningful follow-up questions and proposing interesting discussion questions. However, their cautiousness made them think further: what if those strategies did not work, and people bump up a thread with meaningless comments to win? In their perspectives, even facilitating the discussion was a challenging task; the only way that they believed it could be conquered was by cheating, which did not make them feel competent. Therefore, the value of the facilitator bonus in their minds was not the same as in their peers’ who believed it was their endeavors that would make them win the bonus. Therefore, to the two students, the higher value of the experience points signified amotivating meaning they did not see the value of the task and winning it did not present their competence.

This led to another question, why did the two students hold this view? Both of the two students were the facilitator of week 5—did their peers' performance make them generate this conclusion? According to the LSA diagrams, the N-loop and B-loop were significant response chains in both week 3 and week 4 in the RGC; none of the significant chains included Non-academic response. This indicated the discussion in the previous two weeks contained knowledge building features. While in week 4, there was one significant chain that included the Paraphrase response; the transitional probability was 31.03%, indicating 31.03% of the Initial responses were followed by Paraphrase responses. Therefore, their concerns of students' gaming the game was rather reasonable since in week 4 the LSA diagram was not perfectly aligned with the conceptual knowledge building model (IAM). But their concern was also relatively unfounded since the weekly LSA results showed the RGC discussions were better than the other two versions of the course in terms of knowledge building.

Another reason why the two students shared this view could be due to the common concerns about game and learning shared by some game researchers. Linderoth (2012) once argued that progression in games can be an illusion as games were designed to provide affordances to players, and progressing "is not solely a matter of learning." (p. 58) S45 planned to use gamification with her own students, and S47 had studied gamification for his honor's thesis, a course project, and his own entrepreneurial practice. Apparently, S45 and S47, as members of the gamification community, shared a similar view as Linderoth. So they had higher expectations of the gamification design, which should take measures to ensure that the participation was a matter of learning in the course. This facilitator bonus design in their view failed to reach this expectation and lacked value to them, and, thus, undermined their motivation.

Attaching the experience points to the final grade obstructed the autonomy needs. For Student 49 (S49), the experience points signified the controlling information due to its relationship with the final grade and the design of its algorithm.

Though S49 valued the facilitator responsibilities, overall, she mentioned multiple times that she did not care too much about the experience points. The final grade was more important to her. She wanted to "finish the work as well as possible, as fast as I can." "The work" referred to the part of the final grade that was associated with the experience points. S49 intended to use the least time to do the most in order to have a perfect participation score so that she could have time to read the recommended book, the "real learning." In her perspective, winning more experience points did not equal learning; it was just a means to earn the participation score. For S49, the experience points were simply a "childish" sugar coating for the tasks listed in the syllabus and required by the instructor. For example, she only participated in the peer evaluation activity as she realized that she could earn the experience points. Since the experience points were related to the participation score, the peer evaluation activity then became an activity that was required in the course. Therefore, she started to finish it every week.

Moreover, to S49, the students' interaction was less valuable compared to reading books or to interacting with the instructor. When we had the interview, the course just ended. S49 said she was still reading the books. When talking about her suggestions for the course, she said,

> I hope we don't need to respond more and more to each other to get promoted. we can have some peaceful time to read more books. we can read more

> reflections, I like the notes part, classroom notes, and nowadays, when I read some books, I will do some notes. (S49, Face-to-face, 08/14/18)

In S49's case, the interaction with content and with the teacher equaled learning. However, the gamification design was to promote students' interaction, which did not display any mastery of the subject matter from her perspective. Since S49 was determined to earn the perfect final grade, she had to be involved in students' interaction in order to be "promoted" to earn the perfect participation score. S49's autonomy needs were not satisfied in the RGC. The activities she valued and liked to do, sharing reading notes (the interaction with content) and facilitating the discussion (the challenging task), did not earn her enough experience points to achieve her goal. Therefore, she was forced to post in the discussion forum.

S49 had been on the designer's side of gamification when she was a K-12 teacher. She enjoyed integrating game elements into schooling in her previous job. She believed for younger children, these game elements were important since they changed the "dull" school life. For adults, who she believed were intrinsically motivated to learn, gamification was dispensable. S47, who consider himself as having in-depth knowledge of gamification (bachelor's degree thesis), had a similar point of view towards experience points. He loved "the fact that it (experience points) was there," but he "almost felt tempted to not care simply because it felt like I was being manipulated." However, several interviewees mentioned that they had learned from S47's messages in the discussion forums. Particularly, S44 shared that though S47 was at the bottom part of the leaderboard, he did contribute to the discussion by highlighting some important themes in the readings. The three best speech badges S47 had won from three weeks supported the interviewees' statements. Therefore, it was fair to conclude that S47 satisfied his autonomy needs by choosing to post meaningful messages in the discussion forums instead of fully engage in all the gamification activities. The personal experiences with gamification as designers and researchers for S49 and S47 made them view gamification as a way to manipulate students. However, their reaction to the gamification activities was different. S49 valued both the final grade and learning; therefore, she tried to do whatever she could do even though she did not find value in these activities. While S47 also valued learning, he made the decision to do only what his time allowed him to do, and, thus, he did not earn the perfect participation score.

Experience points summary. In short, students held different views of the experience points in the gamification design, which made the experience points either satisfy or undermine their competence and/or autonomy needs. Some students' competence needs were satisfied because they believed the experience points recognized their efforts and displayed their mastery of learning. When the learning that students valued was not the focus of the gamification design or the design deficiency was identified by students, they would not feel recognized and also felt forced to participate. Thus, the autonomy needs faced the danger of being undermined.

Badges

Badges were another component of the positive feedback system in the gamification design. Different from participation points that were designed to award participation, the five badges were intended to set up performance expectations in the course since only the top performers could win the badge. Additionally, a badge was not associated with the final grade. Among the five badges, three of them were targeted on the discussion forums, which were the focus for this study. The Inspiring badge was designed to award students whose messages attracted the most replies. The resourceful badge was to award students who reached out to various classmates in one discussion thread. The best speech badge was to award the highest quality message voted by students. The deliverable of the peer evaluation activity was one of the changes made in the revised gamification design. In the PGC, the activity used the rating system embedded in the Blackboard discussion forum. In the RGC, it used an anonymous Qualtrics survey including two questions: "who you have learned from this week?" and "which is the best message in this week's discussion?"

Students' understanding of the badge influenced their perception of the badges' value. The definition, the algorithm, and an example of each badge were provided to students in the gamification rules section on Blackboard. Half of the interviewee's understanding of the badges was aligned with the design intention. However, some students took the name of the badges literally when asked to interpret the meaning of the three badges related to the discussion forums. This happened most to the Resourceful Badge. For example, S41 believed the reason she won the badge was that she provided a lot of resources in the week. Student 42 (S42) believed that in order to win this badge, the student should not only reply in the discussion forums but also needed to go back and forth to provide evidence for the argument. They appreciated the "Resourceful Badge" deeply because they believed "the badge" encouraged in-depth learning in the course.

Some students admitted that they did not differentiate the badges from each other. For S45, when she won a badge, she saw it as recognition for something that she did. There was no necessity for her to figure out the differences of each badge. S47 shared similar ideas that the badges in the course were an "unexpected bonus" of "posting like you would normally, but then to be recognized for something that you were able to contribute." Therefore this non-differentiation behavior showed that these students did not particularly do something to win the badge but felt recognized by the peers or the instructor.

Ryan (2016) discussed that the intuitive control of a game was associated with the experience of presence. When the game mechanic was easily mastered, it promoted the immersion feeling in the game since the player's energy was focused on game play rather than being confused by the rules. When this immersion feeling increases, the players feel greater autonomy to pursue challenges and greater competence to take effective actions. When playing games, people tend to skip the tutorial that teaches them to play the game, as it is boring (Burgun, 2013). The RGC gave students extra time to learn the gamification settings, but it did not solve the learning gamification issue entirely. When playing games, the learning of the game rules happened in a trial and error way. However, in the gamification design, since these students did not intend to win the badges at first, wining them strengthened their false understanding of the gamification. However, since the badges were a positive recognition, wining the badges still satisfied their competence needs. Additionally, the badges did not undermine the autonomy needs because they became naturally occurring awards.

S49's case was different from the above. She still did not care about the badges, though she won the three badges in most of the weeks. She believed that the "badge are good for students in secondary school [Why?]. Because we are adults, we don't have many time to care about the rewards." Similar to her standpoint on the experience points, she claimed that her outstanding performance that won badges for her was because that was required by the course instead of an enthusiasm for winning the badge. S46 shared the same view. He performed these expected learning behaviors and won several badges because he was intrinsically motivated by the course.

There were similarities between S45, S47, S46, and S49. They did not do anything particularly for their badges; it just happened to be what they did won them the badge. For example, what the badge awarded was just what they normally did in an online course, required by the instructor or their way of learning. The only difference was S49 saw the badges as a sugar-coat for the course requirements, while the others explained the badges as a positive recognition. S49 experienced the controlling aspect of the badges so that her autonomy needs were undermined, while the other students experienced the informational aspect—winning the badges satisfied their competence needs.

The Best Speech Badge and the Peer Evaluation Activity. Students' understandings of the best speech badge were the most invariable as it was more straightforward and involved students' participation. The interviewees had clearly stated that this badge encouraged them to compose quality messages. "Quality" referred to being good enough to be acknowledged by peers. For example, S48 shared there was one week he thought the discussion was hard, "I remember submitting my posts and thinking, 'man, my posts were terrible this week'." However, he won the best speech badge in that week and felt accomplished and that he should self-doubt less. S41 shared a similar experience. As an English language learner, she always doubted her writing skills and wondered whether other peers could understand what she wrote. To her, the badge was an additional interaction channel that she knew what her peers really thought about her messages, as it was nominated anonymously. The native speaker S45 also had doubt of whether her classmates could know the effort she put in each message; therefore, winning the best speech badge was her confirmation that other students were appreciative of her messages. Therefore, this badge worked as a reminder for students to write quality messages but was also used by students as a confirmation of their efforts. S41, who questioned the experience points' emphasis on quantity, liked the best speech and the voting activity as it was a quality assurance mechanism in the course. The winning of the best speech badge did not only satisfy students' competence needs, but also the relatedness needs since the badges were recognition from peers.

Though the interviewees all agreed that the badge and the peer evaluation activity promoted quality in the discussion forum, they did not participate in the peer voting due to various reasons. One was the schedule conflict. The peer vote opened on each Friday and closed on Sunday night. For some students this period was not their study time, so it was easy for them to miss the deadline. The other reason was that for some students it was too hard to choose only one message to nominate between two or three messages they rated highly. One particular case showed a different reason for not participating in the peer evaluation. S42 explained to me that he worried that somehow he would slip out that he did not vote for his friend when meeting or chatting with them. The relatedness needs in S42's case stopped him from participating in the peer evaluation activity. Moreover, his concern also revealed that the existing friendship would influence the fairness of the peer evaluation activity.

Concerns of the badge design. Different from the experience points, the badges in the gamification design were not related to students' final scores. Even though S46 claimed that his performance in the discussion forums was not for the sake of badge winning, he expressed his confusion about the relationship between the badges and the final grade. The value of the badge to him was vague since he wondered whether winning the badge would influence his grade. His other concern that influenced his perception of the badges' value was that he wondered why there were multiple winners of a badge in a same week. In his understanding, there should be only one top performer. These concerns reduced the perceived value of the badges in S46's case. In other words, his learning habits had been recognized through receiving the badges but not to a degree that his competence needs were strongly satisfied. However, since his learning habits were not due to the desire of winning a badge but a volitional engagement in learning, his autonomy needs were not undermined by the existence of the badges.

There was also concern of the algorithm deciding the badge winners. S42 raised questions about the Inspiring badge, which encouraged students to write original opinions in order to attract comments from various peers. S42 shared his observation that some messages attracted more repliers because the content was related to "contemporary issues" rather than the objectives of the discussion. From S42's perspective, the standard of choosing the winner of the Inspiring badge was not aligned with the instruction goals. So, the design deficiency dropped the value of the badge; thus, winning the badge did not signify the mastery of the subject matter, so it did not satisfy S42's competence needs.

Badge summary. In conclusion, the design feature that the badges were not associated with the final grade did weaken their influence on the competence needs satisfaction to one student. However, since the badges did not influence the final grade, students' autonomy needs were not undermined as the badges naturally occurred to them. Moreover, the majority of students believed in the value of the badges; they were convinced that winning the badges proved they did good work in the course (even due to misunderstanding). So, their competence needs could be satisfied. Conversely, when the students questioned the algorithm of the badge, resulting in the decline of the perceived value of the badge, winning the badges did not satisfy their competence needs. Additionally, the best speech was decided by peers; thus, it further empowered students who had doubts in their contribution to the discussion. Both their competence and relatedness needs were satisfied through winning the best speech badge. Finally, students' various understanding levels of the badge supported the postulation that gamification was not intuitive to students; it took time for them to learn it. In the RGC, extra time was provided to students to learn the gamification setting but the misunderstandings still existed. Future gamification designers should take this “price of admission” into account and make the design more accessible to the majority of students.

Leaderboard

The leaderboard was used in the gamification design to present students’ accumulated experience points and the badges earned in the week. The leaderboard displayed the selected country of students instead of their real names. The leaderboard updated twice a week on Monday and Thursday. An email notification was sent to students when the leaderboard was updated. Accompanying the leaderboard, another section called “My points and badges” showed students their own accumulated experience points and badges, and it was only available to the individual student.

According the Blackboard log data, the majority of interviewees checked the leaderboard when they received the email notification. The weekly average data showed that they checked the leaderboard as often as the personal page, and both means were slightly higher than the class mean.

Among the interviewees, S48 shared he almost never checked the leaderboard until the last week of the class. Instead he checked his personal page more often. This was because he set up his own goal at the beginning of the course—to reach the highest level (gaining the perfect participation score). Therefore, he was not concerned with becoming No. 1 in the course, and the personal page had provided enough information for him to reach his goal. S48 intentionally avoided the competition during the course. When he checked the leaderboard in the last week and found he was in the top half of the class, he was satisfied with the final result. According to Landers et al. (2017), using a leaderboard had similar influences on performance as setting up a difficult and impossible goal. In S48's case, his goal was a difficult goal, thus not checking the leaderboard did not have any negative influence on his performance as his goal with the personal page could help him enough to evaluate his own performance. Compared to S48, the other student's experience with the leaderboard was more complex.

Using leaderboard as a tool of evaluation. Most of the interviewees set goals for themselves, either a specific range on the leaderboard or a rank in the level system that decided the participation score in the final grade. There were also cases in which students started with a specific position on the leaderboard but realized that they could not achieve the goal in the middle of the course, and then adjusted their goal to reach the highest rank in the level system.

Though not every student set up a goal or stuck with the goal of leaderboard over the six weeks, most students used the leaderboard as a reference to check their own performance and regulate their learning. For example, S44 started the course on the bottom of the leaderboard. In the next few weeks, she worked harder to post more frequently in the discussion forums, including messages to the discussion questions and comments to other classmates. She shared that seeing herself moving up little by little was motivating, but she still did not set up a goal of reaching a specific position on the leaderboard. She did not want to be stressed out, especially since the first position classmate had already earned the experience points that she could never catch. Therefore, she decided to earn the experience points to reach the highest rank in the level system.

S46 was determined to end up as the top three in the leaderboard. Therefore, he analyzed why he was not moving up and what he could do to move forward. In his own words, "it encourages me from time to time to evaluate myself and to evaluate my participation in the course." He was satisfied with his final position on the leaderboard. S41 shared a similar experience with S46. She also asked herself why she did not move up, and planned to achieve her goals by participating in different activities. However, due to the busy schedule for her new job (starting at the same time as the course), she realized what she needed and wanted to do but could not complete her to do list. Therefore, the leaderboard did not bring S46 the sense of success.

Dealing with the Comparison and the Competition from the Leaderboard. Even for students who set up a performance goal based on the level system, the comparison and competition from the leaderboard had influences on them. At the beginning of the course, S45 set up a goal of getting “in a certain category” of the level system. She even had a plan in her head of what she needed to do to achieve the goal. But she also checked the leaderboard frequently: “the most once a day, I may miss a day or two, but yes I check it, I check it pretty frequently, yes.” By comparing with other students, S45 could not feel she was making progress: “then towards the end, there were some students that I knew I just couldn’t catch, laugh, I couldn’t catch them.” In S45’s case, checking in with the leaderboard was not as encouraging as S44’s experiences, even though they both sensed the impossibility of chasing the first position classmate and set up their goals based on the level system. When she realized the pressure from checking the leaderboard, she adjusted herself to refocus on her own original goal: “ but I said ok, but if I get up that section I would be happy, doesn’t have to be No.1 spot.”

S45 was critical about the gamification design in this course as she was interested in gamification and planned to use it in her own classroom. She reflected that comparing students with others may not be good for her younger students. Once she adjusted her goal back to the final rank in the level system instead of the leaderboard, she could see herself progressing towards this goal. When the reference was an objective standard rather than her classmate’s performance, S45 could see her own progress. She said that her younger students might not handle the social comparison well, so the level system would work better than the leaderboard.

The other concern of the leaderboard was that it was public to everyone in the class, which could make students who were on the bottom feel embarrassed and demotivated. S42 suggested to make the leaderboard totally anonymous. For himself, he started on a higher position on the leaderboard, which made him feel pressure. He had to put “all of my energy, just to keep up being, just at that level” in the course. S49 shared that even though she thought it was nice to see the country’s names, as all classmates represented different part of the world, the students who fell behind would “be embarrassed.” In her previous gamification experience, she and her colleagues only shared the top 3 or 5 students to the public.

For S45, the leaderboard itself was an issue because some students’ competence needs can never be satisfied when using a peer as reference. For S42 and S49, the leaderboard itself may not necessarily be the issue. It was the way that the leaderboard displayed everyone’s performance, resulting in the issue of embarrassing students. Both concerns reveal that for the students on the bottom, the leaderboard signified the amotivating aspect since they were not able to move up.

Leaderboard summary. In short, students used the leaderboard to evaluate their performance in the course, except in one case in which S48 did not use the leaderboard as a reference at all. However, the leaderboard did not necessarily satisfy students’ competence needs. Only when students achieved their goals or moved up on the leaderboard were their needs of competence satisfied. Moreover, because of achieving the goal on the leaderboard, students needed to work harder than their peer competitors. Participation was not what they chose to do in the course but what they had to do in order to earn more experience points and achieve their goals. Therefore, students felt exhausted when achieving their goals or they felt guilty because of not being able to do all the tasks.

Narrative Environment

Besides the positive feedback system that was discussed above, the other key component of the gamification design was the narrative environment, which was based on the original course design. Students were assigned the role as regional specialist to work together to write a book titled *Educational Consultant's Guide to Effective Use of Educational Technology in International Settings*. During the course, students first selected the country then finished an initial proposal of the book chapter. In the following 5 weeks, they finished two essays that they could use in the final book chapter. On the last day of the course, students submitted their final draft of the chapter. For each assignment that a student submitted, I created a Google Doc file to compile each one's assignments together, then shared it with the class after grading. Also in the beginning of week 4, the book cover vote activity started. Students could choose a book cover for the final book from three graphic designs.

The regional specialist. In the course, students could choose a country for them to work with; the only rule was first come, first served. All the interviewees liked the fact that they were able to choose a country to work with, and most of them chose the country with a purpose, except one case. For example, S44 shared that she was happy that the country was not assigned to them based on where they were from so that she could study the country she was interested in for a long time. Interviewees who chose their home countries felt they learned a lot about their own country. For example, S49 shared when she was facilitating the discussion thread of her own country, she knew more about her country because she had to find more resources to answer the questions that were asked by peers. Besides reading books and papers, some interviewees had also consulted with family and friends in their home country for more information. S42 shared he even got angry when he had a picture of what was happening in his country while collecting materials.

Though the interviewees appreciated the freedom of choosing any country they liked, some of them also admitted that they wanted a guide for selecting a country. Sometimes due to the language barriers, they could not find as many resources as they wanted. In some other cases, they felt that since they were new to the topic, their capacities were not suitable for the countries they selected. S42 suggested there could be a rule that students must write about their own countries as he felt he learned more from the students who wrote about their own countries.

The promotion track. Another component that was related to the specialist role assignment was the level system. All the interviewees agreed that they felt happy when receiving the email notification of promotion. For example, in the beginning of the course, S45 planned what she needed to do in each week in order to be promoted. When she received the confirmation of the promotion, she felt a sense of satisfaction. S46 calculated his own experience points every week; therefore, receiving the promotion email was not a surprise to him as he had already known. But the specialist title in each level added "a little feeling of responsibility" to him and it made him "try to be (a specialist)" and provide unique ideas.

S42 thought that the promotion track could help students to build confidence if they took the course at the end of their program. He believed that these titles were more meaningful and beneficial for that group of students because they would start to work as instructional designers. However, he also shared concerns that the titles of each student were public to all the classmates. He worried that students might judge each other and believed the people with lower titles were not as competent as them.

For S41, the title did not have a meaning for her. The experience points associated with each level were more valuable and easier to understand. Therefore, instead of being promoted to the senior specialist, she paid more attention to the amount of experience points she got.

The essay collections and the final book. The interviewees all appreciated that they were able to see the final product. When interviewing, some of them already downloaded the book and skimmed through it. They felt rewarded when seeing it all together—they "literally made a book." S46 wanted to learn the successful examples and use these resources to create his own country's strategic plan. His first choice was taken by another student, therefore he read his first choice country chapter first and thought it could be a good resource for his future work. Though students shared positive feelings about the book, some of them also admitted they did not read everyone's chapter because of lack of time.

The book cover vote added the authenticity and ownership. The interviewees' attitudes towards the book cover activity were positive—except S45 shared that she liked the activity but did not think this was as important as other activities in the course. Some students thought that the three design plans showed them the book's theme. Some students mentioned the word "ownership" when asked about their experiences of the book cover vote activity. They felt the book was theirs. But S42 believed that only students whose book chapters were selected for the final book should vote for the book cover. However, in the course, there was no rule about selecting some chapters into the book. This student used his real life experience to enhance the authenticity of the book writing activity to himself.

Narrative environment summary. The existence of the final product satisfied the interviewees' competence and relatedness needs to some degree even though not everyone had read the book they have created. The new design features of the narrative environment, and updating the progress of the book and the book cover vote added to the authenticity of the book. The choice of selecting a country satisfied some students' autonomy needs; a few students wanted more structure and for the instructor's authority to have been involved in the country selection process. The titles of each level resonated with few students; the other interviewees saw it as an alternative expression of the experience points.

A Summary of the gamification design on the needs satisfaction

Competence. The positive feedback system was designed to satisfy students' competence needs. The experience points were used to reward participation and the badges were to reward extraordinary performance. Students felt the sense of success when they accomplished a challenging task. However, students' recognition of to what degree the task was challenging depended on to what degree they believed the task was beneficial for learning. Taking the facilitator bonus as an example, when students believed only cheating could achieve the desired number, the task had less value to them. Similarly, for students who questioned the algorithm of the badges, winning them did not bring them the feeling of success.

Additionally, when students' efforts had been recognized, their competence needs were satisfied. For example, some students saw the experience points as a measure of their efforts; therefore, being promoted to the next level made them feel happy. The best speech winners were selected by their classmates. Winning this badge boosted students' confidence as they were recognized by their peers. Even for students who interacted with peers just as what they usually did in online courses, being rewarded because of their good online learning habits made them feel proud. This positive feedback confirmed their way of learning in the online courses.

One postulation made when examining the first design cycle was that gamification was not intuitive to students, and they needed time to get familiar with the gamification rules. Even in the second design cycle, where students had extra time to learn the gamification settings before the course started, there were students who were confused by the gamification rules or misinterpreted and ignored parts of the rules. Some students shared that they had to keep coming back to the gamification rules section to figure it out in the first several weeks. Few students expressed that they had a sense of mastery of the gamification rules. Particularly, some students felt they had to post more and more due to their ignorance of the gap for the experience points in each week, which was a mechanism to keep students from burning out.

Autonomy. The gamification design tried to provide opportunities for students to make a choice in two ways. First, students could choose a country they wanted to work with, select appropriate reading to add to the class library, and initiate a discussion thread. Students appreciated the opportunities to make decisions themselves, but they also liked guidelines or the instructor's authority to help them make a good decision for learning.

Second, the gamification design provided experience points for all the activities that students could participate in; particularly, there were more activities in the revised gamification design. However, the existence of the leaderboard had influence on how students evaluated their performance. Especially for the students who were determined to win the leading position in the class, it left no room for them to choose not to do any activity. When their busy life and work schedule did not allow them to do all the activities, they felt guilty. Additionally, for some students, not doing an activity was not a choice for them. In their standpoints, all the tasks were required by the course; they had to do everything. Therefore, the satisfaction of the autonomy needs depended on what way a student's competence need could be satisfied.

Relatedness. The gamification design addressed the relatedness in two aspects: students' relationship with the class community, and students' relationship with peers. For the first aspect, the gamification design assigned students individual responsibility, and particularly in the RGC, the narrative environment was enhanced by adding activities to improve the final project's authenticity. Being able to access classmates' writing and deciding on the book cover did make some students feel ownership of the book. The level system and performing the facilitation work individually made several students feel responsibility to the class community.

In terms of the relationship with peers, students shared that they felt the discussion was dynamic and their peers responded quickly. The peer evaluation activity allowed the best speech winners to feel recognized by peers. Though students admitted they had learned from each other in the discussion, they still felt they only knew their peers by these academic discussions. For students who did not have class together before, they still did not know them personally. Therefore, even the students' interactions were improved compared to the NGC; the RGC interviewees did not receive much emotional support from the online discussion.

Chapter 6 Conclusions

This chapter first reviews the overall study then concludes the findings for each research question. Following the summary of the findings, I discuss the implications in both applying SDT in gamification design and applying a DBR approach in the online education research, as well as the final gamification design framework. Finally, I have pointed out several limitations of the study and some future research directions.

Overview of the Study

The study used a DBR approach to investigate the PENS based gamification design and its effectiveness on students' interaction in an online course. Several design adjustments were made between the two iterations and during the second iteration. Students' interaction in the three versions of the course was compared in three aspects: quantity, interaction dynamic, and interaction quality. Students' gamification performance data and semi-structured interviews were used to explain the variations of students' interaction in the discussion forums.

Addressing Research Question 1. Students' Interaction Patterns in the Gamified Courses

The PGC students posted significantly fewer messages in the first week than in other weeks and the messages posted in the last week decreased sharply; however, the differences were not significant in comparison with other weeks. In RGC, there were no significant changes of the posting patterns during the six weeks. In the two gamified courses, students received comments from more and more repliers while they sent messages to a similar amount of classmates during the six weeks. In both of the two gamified courses, the percentages of the initial responses presented an increasing pattern and the other three types of responses displayed a decreasing pattern over the six weeks. The group level interaction pattern was different in the two gamified courses in terms of the significant two-response chains. In the PGC, there were greater chances that some follow-up questions were left unanswered and some statements were not fully discussed. In the RGC, the chances of these two situations were smaller.

In short, the students' interaction patterns in the RGC were more aligned with the expected outcomes when designing the gamified course: the message quantity did not show a decreasing pattern, the interaction was evenly distributed among students, and the discussion presented knowledge building discourse features.

Addressing Research Question 2. Comparing Students' Interaction in the Gamified Courses to Non-Gamified Course

More messages were posted in the two gamified courses. Comparing with the baseline year (NGC), the RGC students posted significantly more messages in the discussion forum during the semester. On the weekly scale, students in both of the two gamified courses posted more messages than students in the NGC. Moreover, the facilitator was more actively involved in the discussion in the gamified courses.

The interaction was more evenly distributed among the gamified courses. Students in the gamified courses received messages from a broader range of classmates compared with students in the NGC. Moreover, students in the gamified courses had increased chances to receive a reply after they commented on their peers. Finally, the group level connection was denser in the gamified courses.

More knowledge building behaviors were presented in the gamified courses. There were significant differences of response types in the three versions of the course. The messages posted by the gamified courses' students contained more new-info responses and more building-on responses. For the group level interaction patterns, all three versions of the courses contained significant two-response chains that moved the initial responses forward on the semester scale. In the NGC, the initial responses were more likely to be followed by the building-on responses, while in the gamified courses, the initial responses were more likely to be followed by the new-info responses. Moreover, the PGC students were more likely to leave the discussion unconcluded compared with the NGC and the RGC. On the weekly scale and only in the RGC, the discussion had a greater chance to be further developed during each week. The weekly group level interaction patterns varied between each week in the NGC and the PGC.

In summary, the gamification design in the study had positive influences on students' interactions in the discussion forums in comparison with the non-gamification course. Students posted more frequently and the interaction was less likely to be dominated by a few students. Students presented more knowledge building behaviors in the gamified courses' discussion, while the PGC students were more likely to leave the discussion unfinished.

Addressing Research Question 3. How Does the Gamification Design Influence Students' Interaction?

Based on the quantitative results, the gamification design with enhanced deliverables of the narrative environment (RGC) worked positively in terms of improving students' interaction in the discussion forums. According to students' descriptions of their experiences in the RGC, except for one student who claimed that she did not care about gamification at all (even though she reached the highest title in the level system), the other students admitted that they had been influenced by one or several gamification events during the course.

Leaderboard updates. The gamification performance data showed that most students checked the leaderboard and personal page on the dates when the information was updated. More students chose to check the leaderboard over the personal page. The majority of students used the leaderboard to evaluate their own performance, but not all of the students set or stuck to goals of reaching a certain position in the leaderboard. Particularly, one student who climbed up the leaderboard week by week expressed that the leaderboard encouraged her to post more and reply more in the discussion forums.

Leveling up. Some students set goals of reaching the highest level from the beginning of the course, and some adjusted their goals from climbing up the leaderboard to achieving the highest level in the middle of the course. Several students used the level system to make plans for the week. For one particular student, the level system had made him feel a sense of responsibility and encouraged him to share unique ideas.

Badge and peer evaluation. Even though misinterpretations of the badges existed among some students, badges raised students' awareness of what was expected in the discussion forums. Students did what they thought the badges were encouraging them to do. Particularly, the best speech badge encouraged students to write quality messages. It helped the winners to build confidence once they received the badges. The peer evaluation activity made students read peers' messages carefully, which laid the foundation for knowledge building discourse.

Facilitator bonus. The facilitator bonus, the item that contained the highest amount of experience points, was irresistible to the majority of interviewees. Students who were determined to win the bonus had tried different strategies, including carefully selecting readings, initiating meaningful discussion questions, and asking relevant follow-up questions.

Regarding to what degree the above gamification events resulted in the variation among students' interaction, it depended on students' understanding and attitudes towards the gamification design. In general, for students who believed that accomplishing the tasks could represent their effectance in the course, they were proactive in challenging themselves to accomplish the task. However, the active students in the course were not all motivated by the gamification design. Some students were determined to follow the requirements in the syllabus, and some students expressed that they were intrinsically motivated by the course content.

Overall, the revised gamification design brought positive influences to students' interactions in the online discussion forum. Each gamification element satisfied students' competence, autonomy, and relatedness needs to different degrees for each student. The lessons learned from the study and the final gamification design framework are presented in the following section.

Discussions and Implications

Discussions on applying SDT in gamification design

Most studies on SDT were laboratory experiments (Ryan & Deci, 2017). This study, which was conducted in an online graduate level course, added empirical evidence for both the effectiveness and ineffectiveness of applying SDT in a real-life educational setting. The gamification design in the study was based on the PENS model, which summarized the game design elements that satisfied gamers' competence, autonomy, and relatedness needs (Ryan & Rigby, 2007). The quantitative analysis in the study showed the effectiveness of applying the PENS model in the gamification design in an online course. The semi-structured interviews collected students' descriptions of their experiences and thoughts about the revised gamified course. These experiences revealed more complex findings of whether or not students' three basic needs had been satisfied by participating in the course activities.

Can a gamification design address both competence and autonomy? One criticism of gamification was it promoted extrinsic motivation which would not last for long (Looyestyn et al., 2017). According to SDT, having the positive feedback system alone cannot ensure the increase of intrinsic motivation (Ryan & Deci, 2017). It was important to have the participants experience both competence and autonomy. The positive feedback system should avoid making participants feel as if they are being evaluated or manipulated. This study found that pursuing the competence needs compromised the autonomy needs.

The influences of competition. Most interviewees expressed their opinions of the leaderboard from a social comparison perspective. The badges were also competitive; only top performers could win them. However, few interviewees expressed feeling pressured to win a badge. One reason could be that some interviewees misunderstood the badges' meaning or did not pay attention to the rules of winning the badge, since badges were not associated with the final grade. During the interviews, some students described the badges as a naturally occurring award that they did not do anything specific to win. The quantitative results were similar; particularly, the out-degree badge did not work as other gamification elements, since the out-degrees were not significantly different in the three versions of the course.

The leaderboard brought a more straightforward competition. Even though the first place would not win any extra experience points or final course grade, it was still attractive to most students. According to Ryan and Deci (2017), this was because the leaderboard involved ego. Students felt the pressure to compete for higher positions on the leaderboard because they might believe this was what their peers would value. Under this pressure, some students gave up their original goal of achieving a certain spot on the leaderboard and set up a new goal about the level system, in order to feel their own progress. Other students were determined. For those who achieved their goals on the leaderboard, some did far more work than their peers and felt exhausted after the course instead of satisfied. For others who did not achieve their goals, they felt guilty about not being able to do everything. Therefore, students experienced the leaderboard as an internally controlling event, which left less space to choose what tasks to finish in the course.

To what degree a task affirmed individual competence depended on individual perception and decided individual choices. The gamification design rewarded students experience points when they completed course activities. Regular experience points rewarded completion; bonus experience points and badges awarded performance. Experience points could not be traded for any tangible rewards which could diminish intrinsic motivation according to Ryan and Deci (2017). However, since the final experience points decided the final participation points, which took up 40% of the total grade, they could be considered tangible rewards (Ryan & Deci, 2017). Besides experience points, the badges awarded to students with extraordinary performance were not related to the final grade, which could be seen as a form of praise.

The quantitative findings presented positive effects of the experience points on the number of messages posted, while the interviews supported the argument that the impact of the rewards on intrinsic motivation depended on "the psychological meaning of the event for the individual perceiver with regard to autonomy and competence" (Ryan & Deci, 2017, p. 130). Particularly for the facilitator bonus, which equaled 10 times the experience points as posting a single message, students presented different understandings of the award. Two students believed this task was unable to be achieved except by cheating. Thus, they were not proactive enough to win the bonus. While the other students tried different strategies to achieve this task, they believed this task could prove their ability and benefit their learning in the course.

Ryan and Deci (2017) discussed the risks of the outcome-focused rewards for which people would take the shortcut just for the rewards or choose the easiest way to yield the expected results. In one gamification study, school children chose the easiest physical activities when provided points as rewards, while without rewards they tended to choose the harder activities (Ahn et al., 2019). In this study, the adult students foresaw the shortcut to win the rewards, yet they did not choose to follow it, but, instead, to give up. For two students, the bonus was outcome-focused, which signified a controlling aspect, and winning the bonus would not affirm their competence. They experienced the amotivating aspect of this bonus since it signified incompetence to gain the outcome. For students who perceived the competence affirmation from wining the bonus, they experienced the informational aspect of this bonus. In the interviews, they shared the strategies that they used so that they could prove they did not cheat for the reward. There was also one student who believed that facilitating the online discussion was an important skill for online educators, therefore, as an instructional design major student, she valued the task particularly because she could practice the skill in the real-world: an online course.

Students' reactions to the facilitator bonus depended on their explanations of the ways to obtain it. It was the design of this activity to leave space for students to explain to themselves to what degree winning the bonus could satisfy their competence needs; ultimately, they made their own choices. If the activity design provided some additional scaffolding, such as facilitation strategies, it might reduce the chance of students experiencing the amotivating aspect of this bonus. In previous research (Yildirim et al., 2016), the badges contained not only information about which competency level they represented, but also explanations about how to achieve the learning outcomes and win the badges. This design reduced the chances of the badge signifying incompetence and being perceived by students as controlling.

When it came to learning, who should have made the choices? The relatedness needs that the gamification design focused on was from a student's connectedness perspective. However, during the interviews, students' dependency or expectation of having the instructor make choices for them emerged. Ryan and Deci (2017) claimed that relatedness to the authorities is related to autonomy. When children are close to adults, whether they can or cannot make choices does not influence the intrinsic motivation. In this case, some students preferred the instructor to make the decisions, such as deciding which country they should work on, as they believed that it could make them learn better. For these students, transferring this type of decision-making right to an authority would not make them perceive it as a controlling event.

Besides “what to do”, the choices in the course also included “how to do”. In the gamification design, the data of the class notebook activity showed that giving students the right to decide “how to do” improved participation. In the RGC, students could create new pages for their own reading notes instead of adding notes to a pre-set page. More students participated in the activity and more notes were created.

Probably, for the adult students, the choice of “what to do” was more relevant to what they could learn and how to learn better. Therefore, they would not mind leaving it to an authority figure in whom they have trust, the instructor of the course, in this case. But in terms of “how to do”, they would rather have room to decide for themselves.

Discussions on Applying DBR in Online Course Design

Beyond implementing a PENS-based gamification design in one online course, the use of DBR allowed the study to refine the gamification design framework with a focus on improving the expected learning behaviors.

Appling DBR led to test the theory-based design conjectures. By conducting the two design and research cycles, I was able to use the results from the study to improve the gamification design and to further examine the postulations based on these findings. For example, in the first iteration, by comparing the data from the prototype design with the original course design, it revealed the effectiveness of the gamification design used in the online course, but it also identified problems of lower participation in the first week. To address the problem, I kept the major design (a positive feedback system with a narrative environment) and proposed a new implementation plan which took the competence needs of learning the gamification settings into consideration. The PENS model (Rigby & Ryan, 2007) proposed that the process of learning to play the game influenced the gamers' competence needs satisfaction. In order to make the students feel less frustrated with the gamification settings, the new implementation plan took the gamification settings description back to the learning management system and gave students extra time to learn it before the course started. The improved first week performance in the second iteration proved the effectiveness of the changes.

Moreover, I had also reconceptualized the relationship between the positive feedback system and the narrative environment. In the prototype design, the narrative environment was a standalone element within the gamification design. It was delivered through the first email, which told the students in the course that they would write a book together. What was gamified in the prototype design was in fact the achievement system in the course. Students' participation requirements were not changed much: from reaching a minimum standard to a "Do More, Get More" rule. The two complementary course activities, the writing project and the discussion forums, became two competitors for students' attention and energy. Therefore, it was possible that because students tried to post as much as they could in the discussion forum, they left the book chapter writing task until the last week. In the revised design framework, the narrative environment was used to create a practice field based on the original course. The narrative also kept developing as a result of students' actions. By sharing the essay collection to document progress in the making of their book and having students select a book cover together, the writing project became an ongoing project instead of a final week assignment. These changes informed students that through this process, they were becoming knowledgeable regional specialists. Their book was also on its way to becoming real because of their efforts. Moreover, the authenticity and ownership elicited and maintained students' intrinsic motivation in the course. The number of messages in the last week did not decrease sharply in the RGC. Some of the interviewees shared that they did not feel stressed out about finishing the book chapter during the last week, as they had finished it step by step during the course. However, one student shared that he felt students were struggling with finishing the writing and posting on the discussion forums during the last week.

Besides the design decision made between the two iterations, the micro analysis also contributed to the final design product. Upon identifying that the students' posting behavior patterns might influence the interaction quality (Cheng, Zhang & Lei, 2019), a new bonus experience points item was added which encouraged regular posting. Because of the data analysis in the first design iteration, I noticed that students who came back to the discussion threads multiple times per week presented more knowledge building behaviors. Thus this "side" finding informed the design decision made in the micro cycle in the second design iteration. For the class level interaction pattern, the significant two-response chains in the RGC represented higher levels of knowledge building discourses and the quantity of these two-response chains were higher than in the NGC.

Appling DBR led to the adjustments of the research design. In order to better understand the design conjectures in the study; first, whether the gamification design worked as the PENS model predicted that students' three basic needs would be satisfied and second, whether the enhanced narrative environment better contextualized the gamification activities in the original course design, decisions about including interview data from students were made before the start of the second iteration. The data from students' experiences and perspectives about the revised gamification helped me, as the design researcher, to address the theoretical issues. Eight out of 13 students finished the interviews. The findings were presented in Chapter 5 and informed the discussion of the SDT in the above section.

In order to better understand class level interaction patterns, the data analysis technique was adjusted in the final comprehensive analysis. The sub-phases of the IAM model were regrouped into four major types: Initial response, Paraphrase response, New-info response, and Building-on response. In this way, it better captured the features of the interaction quality in the selected course and improved the sensitive degree of the IAM model when measuring the knowledge-building discussion in this study. Since students discussed different countries in the discussion forums, feeding additional examples and information to peers in the discussion forums were important in this case. Thus, in the LSA results, the four response types clearly depicted the class level interaction as how the Initial response was developed, whether follow-up questions were answered, and whether new points were discussed. Decisions about analysis techniques helped in understanding the class level interaction in the course context.

In summary, from a practical perspective, documenting the design and implementation process (Chapter 4) could help other researchers and practitioners to assess the potential effectiveness of using the gamification design framework in their own contexts. From a theoretical perspective, besides adding empirical evidence to the established theories of motivation and learning, this study has added knowledge on understanding students' interaction in online education. The results from the study demonstrate that regular participation in the discussion forum could create a dynamic asynchronous academic discussion, however, the academic discussion itself may not provide enough emotional support for students to reduce the feelings of isolation in online education. Therefore, one future endeavor could be to focus on satisfying students' relatedness needs (with peers and with instructors) in online education.

The current learning management systems make students' learning behavior data accessible to instructors and researchers. This provides the conditions to use DBR in online course development. Using the learning process information to make data-informed decisions could benefit students' learning and provide better understanding of the effectiveness of the course design (Wise, 2014). One lesson learned from this study was that the online courses were "continuum" in comparison with the "discrete" face-to-face courses. I planned to use the first two weeks' data to conduct the micro cycle, however, the analysis of the data needed time while the course was still going on. Therefore, I had to use only the first week's data in order to make any adjustments needed in week 3, when two thirds of the course was left. It was important to plan ahead for the time cost of the data analysis and the decision making process in order to implement any design adjustments in time.

Implication on Gamification Design for Online Courses

Gamification design has been used in educational fields for years. There was no unique way of choosing and designing game elements, and the results from gamification studies were also inconsistent. This study explored the PENS-based gamification design and has provided empirical evidence of its effectiveness and ineffectiveness. Based on the findings from the study, I proposed a generic gamification design framework in order to help future researchers and practitioners to design their own online courses with gamification.

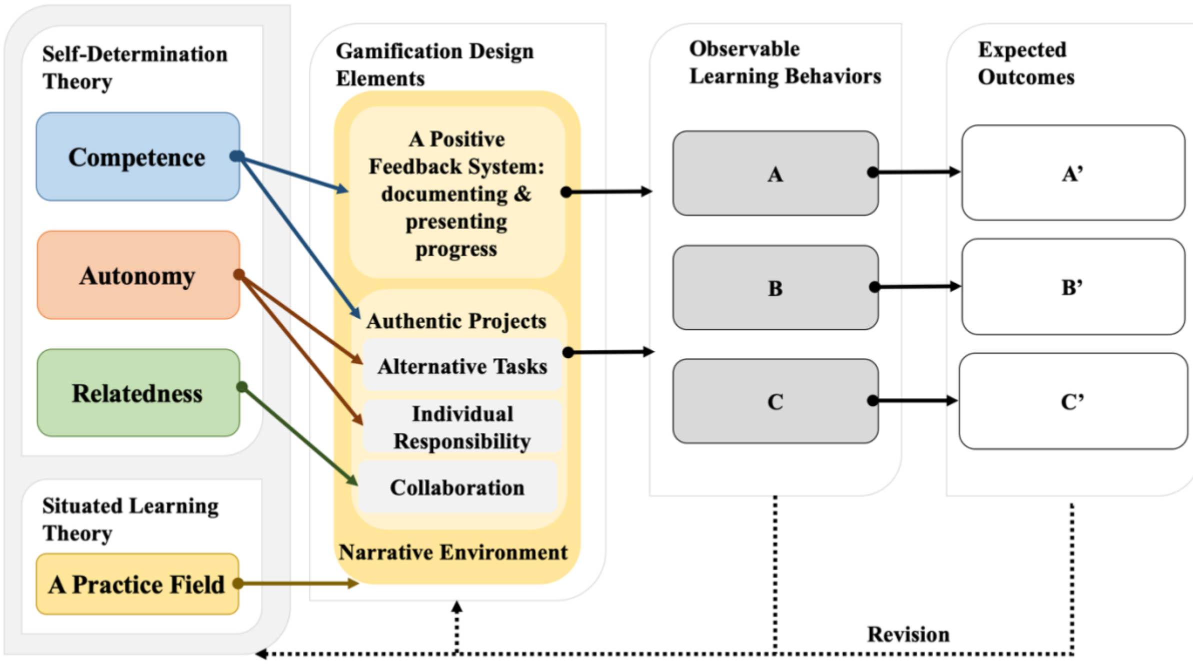

Figure 24 *A Generic Gamification Design Framework*

The gamification design framework included a positive feedback system embedded in a narrative environment. The positive feedback system is the motivation layer that rewards the learning behaviors leading to the expected learning outcomes. Instead of using a random fantasy fiction, the narrative environment should be based on the subject matter, such as authentic learning projects. Therefore, the gamification layer does not only revise the achievement system, but also integrates the design principles into the course design.

First, the positive feedback system should reward the expected learning behaviors. Therefore, students feel that they are being recognized through engaging in the learning activities, satisfying their competence needs. Particularly, experience points and badges can be designed to reward participation, completion, reaching a performance standard, or winning. The values of the points should be carefully chosen so that they match the degree of challenge for each task. For the extremely challenging tasks, the designer could provide information that helps the leaners to succeed in order to keep the learners from giving up too easily. Both the leaderboard and level system could be provided so that students can use either of them to set up goals for themselves, thus creating learning plans. However, the leaderboard as an external evaluative tool, if perceived as such by students, could make it become an internally controlling event thus diminishing intrinsic motivation. Therefore, the deliverable of the leaderboard, either public or private, should be carefully considered. The level system was noncompetitive, thus it could make students feel they keep progressing.

The narrative environment should provide an overarching theme for the gamification design. Particularly, it should be domain-related and provide a coherent interpretation of the course projects and the positive feedback system. Creating an authentic task as a practice field is recommended in this design framework. The “core” practice (Huotari & Hamari, 2012) in a gamified course should be a learning practice. Then the positive feedback system is used to promote students’ engagement in the learning practice. Moreover, the narrative environment could be used to enhance the authenticity and ownership of the learning projects. One way to do so is to have the narrative continue to develop due to students’ actions. It could help students keep their intrinsic motivation from being undermined by the controlling aspects of the rewards.

Finally, there are another three elements that are recommended in the design framework. Individual responsibility and collaboration are both important in an online course and they can be highlighted by rewarding points and badges. Collaboration through interactions in the discussion forums or other projects could benefit learning and reduce feelings of isolation in online courses. The individual responsibility shares, but does not totally transfer, learning accountabilities to students. When possible, in addition to giving students space to choose what to do, students should also be allowed to decide how to do it so that they could make meaningful interactions with the course. Last but not least, alternative tasks in the design framework were referred to the diverse learning activities that provided equal learning opportunities to students. The design of each learning task should take students' values about learning into consideration. These activities should not be created only for the sake of providing additional options to give students autonomy or it may just overwhelm students.

Limitations

In spite of documenting the course context, the participants in the study were students who majored in an instructional design related program. By the time they took the course, they had learned instructional design in a systematic way at least for one semester. They were sensitive to the gamification design applied in the course and were reflective about the gamification design. It cannot be ignored that they were in-training instructional designers. Their knowledge of instructional design had influenced their understandings of using gamification design in the course. The characteristics of the participants could have influenced their engagement in the gamification design of this course.

The study focused on students' behaviors during peer interaction, therefore it did not include any learning performance test. The influences of gamification design on learning were not fully examined. Finally, the study did not measure students' intrinsic motivation directly while examining weekly participation as the proxy of the motivation measure. In the future, the gamification design could be tested in other subject areas. More log data from the learning management system should be used. For longer courses, students' learning and their intrinsic motivation could be measured directly multiple times over the course period.

In this gamification design, I did not create any new platform besides using the functions already available in the Blackboard. Even though the availability of the Blackboard log data allowed me to update students' experience points and badges in a timely manner, it was still not as immediate as in digital games. Moreover, the workload of tracking every student's progress could be a problem if the class size is larger. A flexible learning management system which allowed the instructors to customize the visualization of students' progresses could help the application of the gamification design framework proposed in the study. Given the popularity of online courses in higher education (Allen & Seaman, 2015, 2016, 2017), such a learning management system could help instructional designers and instructors to create a motivated learning environment.

Appendix I Gamification Design Specifics

None Gamification Course	Prototype Gamification Design		Revised Gamification Design	
Discussion Forum	**Discussion Forum**		**Discussion Forum**	
Two weeks facilitated by the teacher	Two weeks facilitated by the teacher		Two weeks facilitated by the teacher	
Four weeks facilitated by student teams	Four weeks facilitated by individual student (XP and bonus XP)	(8*)	Four weeks facilitated by individual student (XP and new bonus XP rules)	
Students are required to respond once to each thread and respond to one peers per thread	Students post messages in the discussion forum (XP)	(1*)	Students post messages in the discussion forum (XP)	
	Three badges are rewarded to students' interaction and post quality.	(4*) (7*)	Two badges are rewarded to interaction.	
		(3*)	One badge for best post vote via survey (XP)	(3**)
	A leaderboard presents students' accumulated XP and badge earned in the week.	(2*)	A leaderboard presents students' accumulated XP and badge earned in the week.	
Assignment	**Challenges**		**Challenges**	
Initial Proposal of the book chapter	Initial Proposal of the book chapter		Initial Proposal of the book chapter	
Final Chapter	Final Chapter		Final Chapter (published via Google Doc)	
Reginal picture essay	Reginal picture essay (Badge)	(10*)	Reginal picture essay (Badge; published via Google Doc)	(10**)
Educational Technology Project Issues	Educational Technology Project Issues (Badge)	(10*)	Educational Technology Project Issues (Badge; published via Google Doc)	(10**)
			Book cover vote (XP)	(11**)
Class Readings	**Class Library**		**Class Library**	
Readings are offered by the instructor in the first two weeks	Readings are offered by the instructor in the first two weeks		Readings are offered by the instructor in the first two weeks	
Students recommend readings in the last four weeks	Students recommend readings in the last four weeks(XP)	(6*)	Students recommend readings in the last four weeks(XP)	
	Class Notebook		**Class Notebook**	
	Students share reading notes on Class Wiki, and they earn XP	(5*)	Students share reading notes on Class Wiki, and they earn XP	(5**)
			Revised layout of the Class Wiki	
	Promotion Track	(9*)	**Promotion Track**	

	Give students extra days to get familiar with the gamification settings	(12**)

Appendix II Conjecture Mapping of the Study

Expected Outcomes	Learning Conjectures	Design Conjectures	Research Questions	Instruments/Measures
Students participate in the discussion forum regularly	Students will keep to participate in discussion regularly in long-term if participation satisfies their competence needs.	(1*) To satisfy students competence need, **experience points** are given as a positive feedback for students' participation in the discussion	Q1a. How frequent do students post in the discussion forum of the course? Q3a. Whether there are specific gamification events (points update, leaderboard update, etc.) influence students' interaction performance?	Number of messages a student post per day XP per update Interaction depth in a thread
		(2*) To present the competence, a **leaderboard** is created to present students accumulated experience points and badges.	Q2a. Comparing to the baseline year (2016 Summer Semester), does students' interaction in the online discussion forum changes in terms of quantity?	A student's position in leaderboard per week
Students engage in the knowledge construction discourses	Students will continue to contribute quality messages to the knowledge construction discourse if they feel competent by doing so.	(3*) A **badge** is designed as a reward to the peer-evaluated best messages in each thread per week. The badge serves as an optimal challenge for students, by winning which students can present their competence. (3**) The peer-evaluation process is changed from using Blackboard star rating system to a weekly Qualtrics survey. Participating in the survey will also earn experience points	Q1c. What is the distribution of the interaction phases of students' discussion messages according to the Interaction Analysis Model? Q3b. What is the variation among students' interaction performance under the influences of each gamification events? Q2c. Comparing to the baseline year (2016 Summer Semester), does students' interaction in the online discussion forum changes in terms of quality of interaction?	Interaction Analysis Model Unit of analysis: each message Both thread development and phases of each students' post per week will be analyzed.
	Students will continue to contribute original ideas to the knowledge construction discourse if they feel competent by doing so.	(4*) A **badge** is designed to reward the post that received most comments per discussion thread per week.		
	Students will continue to engage in the knowledge construction	(5*) To offer students other option to present what they learn from the materials, **Class notebook** is		

	discourse if they choose to participate in the threaded discussion. Students will share well-organized notes if they feel their contribution may help other classmates.	created for students to sharing their notes from reading. (5*) **Class notebook** is in the format of class wiki, students post their take-away from the reading materials and share with others. (5**)The layout of **Class notebook** is updated to be easier to navigate.		
Students interaction are decentralized.	Information flow is more evenly distributed if students interacted with various peers	(7*) A **badge** is designed as a reward to students who interact with most various peers in one thread. (8*) Students will win **extra experience points** if their questions attracted all other peers to participate and the student as the solo **facilitator** prompt the discussion	Q1b. What is students' interaction dynamic in terms of SNA measures? Q3b. What is the variation among students' interaction performance under the influences of each gamification events? Q2b. Comparing to the baseline year (2016 Summer Semester), does students' interaction in the online discussion forum changes in terms of interaction dynamic?	SNA measures In-degree and out-degree; distribution of three types of dyad; Cliques analysis; Density; centralization score.
Students treat themselves as writers who are writing a book together instead of students who only pursuing good grade.	Students will more likely to engage in the materials if they have the power to select key readings. Students will more likely to contribute quality materials if they feel their contribution is important to the class community. Students will more likely to keep engaging in the course activity, if they feel competent.	(6*) Students selected materials for the country and share it with the class in weekly folder as weekly readings. Students names are showed in the file name. To better integrate this activity to the gamification environment, the activity is named as Building the **Class Library**. (6) Every reading students contribute to the class will earn them experience points.		

	Students will more likely to keep their participation level during the course, if their competence can be presented.	(9*) **Promotion Track** is part of the narrative of the gamification environment. Students are regional specialist, as they participated in various activities and earned experience points, their progress will be presented in the changing of the titles.
	Students will be more emerged in the gamification setting, if the book writing project is more authentic designed.	(10*) The two writing assignment is renamed as challenges. Two **badges** are designed to reward the best assignments. (10**) The two writing assignment will be collected and published through Google Doc separately after students receive feedback.
	Students will be more emerged in the gamification setting, if the book writing project is more authentic designed.	(11**) When students receive the book chapter proposal feedback. There will be a Book Cover Vote activity through Qualtrics survey.
Decreasing the design curve of gamification.	Students will feel less confused if they have enough time to learn the gamification setting and rules.	(12**) The gamification setting and rules will be send to students two days before the course starts. So students will have time to get familiar with the course.

Appendix III Coding Examples

Unit of Analysis: one response. If one message contains replies to multiple person in multiple paragraphs, each response should be the unit of analysis. When this happens, it should be recorded in the memo. Each response should be considered in the context, which is the thread. Be careful, when response A is not a direct reply to response B, but it mentions points in response B. When this happens, it should be recorded in the memo.						
Phase		**Definition**	**Example**	**Notes**		
PHASE I: SHARING/COMPARING OF INFORMATION	1A	A statement of observation or opinion	S2, As to the question of indigenous groups and ICT: I think that the learners and users should be considered first and foremost whether they are indigenous or not indigenous. It seems ironic that the claim of the ICT studies is that ICT offers indigenous groups the opportunity to record their oral history and traditions that have been passed down face-to-face. I think a factor in implementing ICT within the indigenous groups is that those with the knowledge of the culture are not likely to be the same individuals with the knowledge of ICT nor may they want to share the knowledge globally. Even if ICT comes from within the countries, there is still a divide in Peru between the university urban population and the rural poor as noted in the article. Practically, the issue of resources and initiative would appear to deter the indigenous populations from developing ICT programs. So I suggest a partnership that is carefully established with individuals from within and outside the community.			

	1B	A statement of agreement from one or more other participants				
	1C	Corroborating examples provided by one or more participants	Hi S2, I agree with S6. I think that the lack of use of indigenous groups of ICT are pushing away the idea of developing programs related to ICT. Many indigenous groups lack the resources to invest in such technology. For example, in the US, indigenous groups on reservations lack resources and in result they don't have the quality of education that a school in a suburban setting would have.			
	1D	Asking and answering questions to clarify details of statements				
	1E	Definition, description, or identification of a problem	Hi S5 & S6 I agree that many indigenous groups don't have the resources to develop their own ICT and carefully constructed partnerships established with individuals within the community could help this. The divide between the university urban and rural poor is something present throughout most of South America, and we have been talking about how lack of resources, training, etc. that cause/are inflamed by this. With this in mind, what are some unique ways that this challenge could be tackled? For example,the Solar Village Program in Honduras set up solar stations to power telecenters in rural villages. This circumvents one (of many) problems of unreliable power grids in a sunny area.	This is an example of one message contains multiple replies to different classmates.		
PHASE II: THE DISCOVERY AND EXPLORATION OF DISSONANCE OR INCONSISTENCY AMONG IDEAS, CONCEPTS OR STATEMENTS	2A	Identifying and stating areas of disagreement	S6 it sounds like you think they might not necessarily want or need to use ICT to record their oral tradition (which I could agree with you on in some cases). But to play devil's advocate, technology has been used to record non-written, little		Comparing to D12, even though they both contains agreement and disagreement, D9 is the first comments S2 give to S6, and D12 is after	

			studied languages throughout the world (such as the project I'm working on now with Wanga), and has also been used to help bring back languages from the brink of extinction. Much of this "oral" history andculture disappears when a language goes extinct (which is happening at an alarming rate with globalization), andtechnology has been an incredible tool in preserving languages and, therefore, oral history. I'd like to hear your thoughts on this.		several rounds of interaction. Therefore D9 is "identifying disagreement", and D12 is "negotiating".	
	2B	Asking and answering questions to clarify the source and extent of disagreement				
	2C	Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view	I don't have any unique ways to tackle the challenge that will reduce the gap but would reiterate that great care and respect should be taken in dealing with cultures different from developed nations. Technology should enhance their lifestyle and community, not make those outside the community feel that a scale has been balanced.			
PHASE III: NEGOTIATION OF MEANING/CONSTRUCTION OF KNOWLEDGE	3A	Negotiation or clarification of the meaning of terms	You bring up some good points. Many times revival isn't viable, and even if it is, it may not enter "mainstream" education. Yet, I would argue that, it doesn't always have to enter public schools to be successful. Something I'd like to mention about "revival" of native languages is that is isn't always meant for the general public, but the native communities themselves. So, for example, looking at the NYS public school system, which would be more likely to have (and then drop) major global languages, isn't the best way to see how Onondaga is spoken within the native community. One of the best examples of			

			revival I can think of is Maori in New Zealand, in which revival has been a way for this group to gain recognition and acceptance. These languages can be taught using ICT. And with many indigneous people living in cities, many have access and knowledge of technology. I understand this isn't successful for everyone everywhere, and isn't the magic bullet for native communities to gain respect and recognition, but it can be an incredibly useful tool.			
	3B	Negotiation of the relative weight to be assigned to types of argument				
	3C	Identification of areas of agreement or overlap among conflicting concepts				
	3D	Proposal and negotiation of new statements embodying compromise, co-construction	I agree that maybe oral histories should remain oral, and of course that ICT should be used to enhance a communities lifestyles. But I would like to pose to you the question of how ICT can be used with dying languages, which unfortunately, is a common phenomenon with purely oral native languages in some parts of the word, (which is why I bring it up again) due to the dominance of languages such as English and Spanish established by colonial rule and globalism. These "oral" histories and culture could and are lost forever. Do you think ICT could have a role in documenting or reviving them?			
	3E	Proposal of integrating or accommodating metaphors or analogies				

PHASE IV: TESTING AND MODIFICATION OF PROPOSED SYNTHESIS OR COCONSTRUCTION	4A	Testing the proposed synthesis against "received fact" as shared by the participants and/or their culture				
	4B	Testing against existing cognitive schema				
	4C	Testing against personal experience	S8, I appreciate that you're bringing a librarian's perspective to all of these discussions. I've always been impressed by all of the services provided by the SU library system and all of your hard work is greatly appreciated! You bring up an interesting point when you say that you work with many international students studying at SU. I've always drawn a pretty hard line between what is international (takes place in another country) and what is multicultural within a country (many cultures interacting within one country). However, your post has made me stop and think that this hard line may be much finer than I originally thought. The perspective brought by your international students will be international in nature, even though it is taking place in a multicultural environment. I'm looking forward to reading more about your experiences in the discussion forums in this course. S9			
	4D	Testing against formal data collected				
	4E	Testing against contradictory testimony in the literature				
PHASE V: AGREEMENT STATEMENT(S)/APPLICATIONS OF NEWLY CONSTRUCTED MEANING	5A	Summarization of agreement(s)	I thought of Maori when I wrote my reply. I believe that New Zealand as a government has been proactive in maintaining an emphasis on Maori heritage and presence on the island. ICT certainly	This is an example of considering the context. Without context this message is an opinion, but considering how S6's views changed, this is in fact is a summary of this thread of argument		

			has the ability to provide the information to a broader audience.			
	5B	Applications of new knowledge				
	5C	Metacognitive statements by the participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction				

Appendix IV Interview Protocol

Thanks for coming. During this interview, you can refuse to answer any questions.

To begin this interview, I'd like to ask you some questions about your online learning experience.

1. Is this your first online course?

[Warm-up questions; Analyzing how previous experience may influence students' performance in the gamified course]

- -*Yes, what was your expectation of online learning before taking online courses? ?* [Possible motivation of taking the course]
- -*No.*
    - *How do you describe your previous experience of taking online courses?*
    - *What was your expectation of taking this course?* [Possible motivation of taking the course]

2. How would you describe this online course experience?

[Warm-up questions; Students' perspective of the gamified course]

Thanks for your response, I'd like to now ask you questions regarding the instructional design in this course.

[*if the interviewee mentioned specific gamification elements in Q2, start from the element.]*

3. *[The interviewer describes the game elements in this course]* **How do you like the gamification design in this course? Either positive or challenges/frustrated.**

[Students' perspective of the gamified course; how does each gamification element influence students' performance?]

- *If the interviewee any specific gamification elements, ask follow-up questions starting from the elements in the interviewee's response.*
    - *What do you think about the gamification element? [*one by one*]*
    - *Do you notice the experience points: Regular and Bonus? Did you do anything to win the Facilitation bonus? Why?* (Note of whether the student win the facilitation bonus)
    - *How would you explain the resourceful/inspiring/best speech badge, for example how to win it?*
    - *How about the peer vote activity?* (Note of Student A voted in weeks …, voted for …[])
    - *Why you do/don't like Element #?*

4. How often do you check your experience points and badges, and leaderboard?

[Analyzing how the differences of students' care of gamification may influence their performance?](Note of Student A checked leaderboard how many times a week, checked personal page how many times a week.)

- How do you understand/explain *points/badges/leaderboard* (to yourself)?
    - *So, what you mean is you use these* ***as standard/reference to you own experience****, can you give me an example?*
    - *So, what you mean is you* ***don't care*** *about the numbers and badges, can you tell me why?*

5. What do you think about the role as regional specialist assigned to you in this course?

[Promotion Track, the level system; Narrative]

- *If the interviewee is aware of the promotion track, ask follow-up questions:*
    - *How would you describe your feelings/reactions when you received the email of notification of your promotion?*
- *If not mentioned, ask how do you like the promotion track*

6. What do you think about the book project in this course?

[Narrative]

- *If the interviewee is aware of the project, ask follow-up questions:*
    - *How would you like the book cover activity? Why?*
    - *How would you like the Google Doc for the essay collections? Why?*
    - *How would you like the Book Cover Vote? Why?*

7. What do you think of the workload in this course? Do you feel you are <u>forced to</u> participate? Do you think this course has many mandatory work for students or not?

[Autonomy]

- *-yes, can you give me an example?*
- *-no, so what do you mean is you feel the course provide you choices in this course, can you give me an example?*
    - *[if the interviewee didn't mention the reasons behind the choice] How did you make your choice?*

8. What do you think about the classmates in this course? Do you think you have learned from your peers? (Note of student A voted he/she learned from..)

[Relatedness]

- *-yes, who? What do you learn from her/him, where (discussion forum/class notebook/class library/assignment) do you learn from her/him?*
- *-no, why?*

9. During the course, were you confident that you would be able to succeed and do well in this course? [Competence]

- *-yes, can you give me an example?*
- *-no, why? Do you me you are often worried about your performance in the course? Can you give me an example?*

10. Have you heard of the term "gamification" before taking this course? [Students' previous knowledge of gamification, whether this will influence their performance in the course]

- *-yes, can you give me an example? Either you heard a product or used one that involved gamification? How do you like it or not?*
- *-No, after taking this course, what do you think about gamification (what is it, if you need to explain it to someone else).*

Before we conclude the interview, is there any other course design or gamification elements that you think influences how you engage in this course that we have not yet had a chance to discuss?

Appendix V Lag Sequential Analysis Tables and Response Chain Examples

Table 40 *Observed Frequencies for Two-response Chains in the NGC*

Given Response,	Following Response, Lag 1					
Lag 0	1	2	3	4	5	6
1. Discussion Question		149			1	
2. Initial Response		3	82	80	110	13
3. Paraphrase Response		1	1	1	3	
4. New-info Responses			3	14	10	2
5. Building-on Response			10	10	23	3
6. Non-Academic Response		1		1		4

Table 41 *Adjusted Residuals for Two-response Chains in the NGC*

Given Response,	Following Response, Lag 1					
Lag 0	1	2	3	4	5	6
1. Discussion Question		22.28	-6.86	-7.29	-8.82	-3.03
2. Initial Response		-15.70	6.66	4.77	5.73	0.41
3. Paraphrase Response		-0.69	-0.10	-0.22	1.21	-0.52
4. New-info Responses		-3.57	-1.14	3.88	0.80	0.75
5. Building-on Response		-4.57	0.63	0.27	3.48	0.83
6. Non-Academic Response		-0.69	-1.17	-0.22	-1.54	7.68

Table 42 *Observed Frequencies for Two-response Chains in the PGC*

Given Response,	Following Response, Lag 1					
Lag 0	1	2	3	4	5	6
1. Discussion Question		112		2	8	
2. Initial Response		6	37	86	59	1
3. Paraphrase Response			6	9	9	
4. New-info Responses		12	10	28	28	
5. Building-on Response		4	10	33	43	4
6. Non-Academic Response						1

Table 43 *Adjusted Residuals for Two-response Chains in the PGC*

Given Response,	Following Response, Lag 1					
Lag 0	1	2	3	4	5	6
1. Discussion Question		18.81	-4.77	-8.06	-6.25	-1.39
2. Initial Response		-9.13	3.78	5.40	0.87	-1.05
3. Paraphrase Response		-3.00	1.92	0.69	0.95	-0.55
4. New-info Responses		-2.39	0.12	0.99	1.47	-1.05
5. Building-on Response		-5.39	-0.57	0.93	3.98	3.06
6. Non-Academic Response		-0.60	-0.38	-0.67	-0.64	9.16

Table 44 *Observed Frequencies for Two-response Chains in the RGC*

Given Response,	Following Response, Lag 1					
Lag 0	1	2	3	4	5	6
1. Discussion Question		153		5	2	
2. Initial Response		4	66	132	105	14
3. Paraphrase Response			3	4	5	5
4. New-info Responses		1	20	71	46	7
5. Building-on Response		1	15	20	51	7
6. Non-Academic Response						12

Table 45 *Adjusted Residuals for Two-response Chains in the RGC*

Given Response,	Following Response, Lag 1					
Lag 0	1	2	3	4	5	6
1. Discussion Question		25.95	-5.73	-8.59	-8.48	-3.61
2. Initial Response		-11.58	4.58	5.20	2.54	-1.64
3. Paraphrase Response		-2.17	0.45	-0.67	0.14	4.11
4. New-info Responses		-6.73	-0.04	5.22	1.14	-0.67
5. Building-on Response		-5.11	0.62	-2.17	6.09	0.63
6. Non-Academic Response		-1.81	-1.40	-2.34	-2.17	13.81

Below is the example of the **I->P** response chains from the **NGC**.

Student 26:

From my own research with my country, and from reading all of the articles, I think the main thing that causes digital inequality is money. For developed countries they have some issues with getting donors, but for the most part they have the money that they need, and have the technology. For developing countries, they fall short when it comes to money, and these countries are the ones that need things like ICT to better their economy. This article talks about how homes and communities that have access to technology are the communities that start new businesses, and increases the demand for technological goods (Grazzi & Vergara, 2). I would suggest finding donors that can give money to developing countries. Also, after the money is given for the technology, it would help to decrease digital inequality to make sure that the technology stays up to date, and that it can be fixed when need be.

When looking at the graphs I was surprised to see the percentage of people in rural areas that have cell phones, and that the number increased so much from 2004 to 2005. I was also surprised by the fact that pretty much no one has access to the Internet, rural or urban. It seems like the country being behind on having a computer and having Internet is what is going to be the most challenging thing, because all of money is going to be involved in getting the people these things. Something that I am not surprised about though is that the people with the most access to a fixed phone line, a computer and the internet is the people with the most education, but even then the percentages are still low. [Code at Initial Response]

Student 20:

I agree with your statement. Money changes a lot of things and can determine different factors. [Code at Paraphrase Response]

Below is the example of the **I->P** response chains from the **PGC**.

Student 13:

Student 11,

I believe a big reason for some teachers not using the technology is their own comfort using the technology. When something is new, sometimes people like to use what they know. Using the technology could be out of the comfort zone. They also may just not want to use the technology.

I think every school distract should educate students on plagiarism, starting at a young age. They also should be aware of the dangers of the Internet. I believe the school should play a big role in this. [Code at Initial Response]

Student 5:

I agree that it is important for students to be educated about plagiarism at a young age. It is important for teachers for all subjects to teach about plagiarisms and how to site information using correct format for that subject area. [Code at Paraphrase Response]

Below is example of the **I->N** response chains from the **NGC**.

Student 16:

Wow...only 6% are Internet users as of the early 2000s??? That's crazy! I see potential risks with this number alone, as it presents an extremely big jump to make if they hope to catch up to countries like the US and Australia. I see a risk particularly with the E-Russia initiative taking place. Though there are a lot of great aspects to the project, I see a potential problem in the area of project management. It's great that there are a lot of investors and stakeholders attached to the project, but that could also bring out issues when it comes to decision making in the future. It reminded me of the issues we saw in that past case where because the projects were being laced on school grounds, there was miscommunication between ICT experts and school management, which led to problems. Perhaps with so many different investors in E-Russia, a similar issue could arise. [Code at Initial response]

Student 22:

Student 16,

You make a great point. In project management there most definitely needs to be a direct chain of command in place. I agree that when too many people are involved complications are more likely to arise as well as miscommunications. However, if a large number of stakeholders and investors are involved in a project for whatever reason, how do you think this can/should be managed? [Code at New-info response]

Below is example of the **I->N** response chains from the **PGC**.

Student 6:

One of the things I find interesting is that Ely's list of considerations in working in international settings is still relevant 20 years later. Although I agree with 4) Bring your family whenever possible, I'm not sure it would be looked upon as favorably today as it would have been in 1996. It seems to be the most situation and project dependent item on the list. I like number 8) …build on the existing system as it is a reminder to build on existing successes and not to start from scratch. Although not an international environment when I worked on a project team to add an accelerated bachelor of nursing hybrid program, the new partner wanted the college to adopt their systems instead of using what was already in place for the seven existing online programs. Many discussions over the course of several months lead to the realization that to make the new system compatible with the old and to train staff to use it was far more complex than using the existing system to achieve the goal.

Source

Ely, D. P. (1996). Educational Technology Professionals Worldwide A Compass to International Understanding. Educational Technology Research and Development, 44(4), 105-109. [Code at Initial response]

Student 11:

This is a great point! I think that many times companies, schools, etc. want to simply get rid of old systems and start fresh, but in somecases this can be more complex--not to mention expensive. It often requires more training and may lead to frustration for the users of the programs. It is often easier to build on existing systems, which requires knowledge of the current state of technology in an area, as well as what is working well and what may need to be fixed. [Code at New-info response]

Below is example of the **I->B** response chains from the **NGC**.

Student 22:

Based on the ICT diffusion graphs, it is obvious that many families of Paraguay do not have access to a working phone line, let alone Internet connection. This demonstrates the ICT growth in this country is quite slow. With less than half of the country having access to a working phone line, about only 5% have internet access. Concurrently, the use of a language like Guarani can have an effect on ICT diffusion because it is not a language that is widely used. Guarani is primarily used in Paraguay along with Spanish. However, wish Spanish being more popular, ICT diffusion can be hindered by a language that is not widely-spoken. [Code at Initial response]

Student 16:

Good points Student 22. With such a slow ICT growth rate, iit becomes even more difficult for tech experts in the US to understand the various needs of developing countries. When we are surrounded by so much technology here, we tend to take for granted the simpler, beginning ICT tools we had with the new ones constantly bombarding us. It then becomes easy to throw ICT tools at countries that are too advanced for them, which is just wasteful and will only cause Issues. [Code at Building-on response]

Below is example of the **I->B** response chains from the **PGC**.

Student 3:

Hi Student 4,

I thought the data in the Zhou article was quite interesting. Although computers are being incorporated into their teaching it seems that measuring the effectiveness is a bit of a puzzle. I agree with the suggestion to use mentoring to share ideas along with the use of rewards system for the students. I'm curious if any countries have rewards systems for teachers who are showing increased academic achievements in their students using ICT, higher test scores, etc. Clearly it's a controversial subject, but motivation to improve learning experiences is varies between different teachers in different stages of their careers. How much time should teachers spend experimenting with new technology they don't know will achieve results? [Code at Initial response]

Student 6:

I also enjoyed the Zhou and Xu article as many statements rang true to me. I liked how they linked pedagogy and technology. Specifically, the idea that "The use of technology is different from the effective use of technology" (p. 510). As Zhouand Xu mention higher education faculty do not have much experience or training with regard to teaching. So to S3's point, how then should instructors spend their time when they don't know what is effective or not effective? If instructors feel that they are achieving results, then why change. Additionally, how do you connect mentors in what is generally a competitive environment for space and funding? [Code at Building-on response]

Below is the example of the **N-loop** response chain from the **NGC**.

Student 16:

Firstly I would like to say how jealous I am that you have had the opportunity to live in Ireland...secondly I am so interested to hear more from someone who has actually been in this country firsthand. I'm curious, when you were there did you have any interest yet in ICT? If so, did you notice a positive or negative shift in any sector in regards to ICT? How was it different/similar to the U.S.? [Code at New-info response]

Student 23:

Student 16, Ireland is an amazing place and I had an awesome experience there! I cannot recommend living abroad highly enough, in Ireland or anywhere that strikes your fancy. It was truly life-changing.

As far as our course goes, I did not have any particular interest in ICT when I lived in Ireland, but I know that the economic downturn that was happening at that time affected nearly every industry. Ireland had experienced an economic boom (called the Celtic Tiger) in the 90s, which was largely due to appealing tax incentives they were able to offer global companies in order to attract them to Ireland. I believe a lot of ICT-based companies were drawn to Ireland during this time. Then, the global recession hit, there was a property bubble that collapsed and led to a huge banking crisis (I think anyway...Student 18 probably knows more about this than I do!)... Anyway, many companies ended up finding cheaper costs of operation elsewhere in Europe. I cannot imagine the ICT companies where any exception. However, I do not think any of this had huge implications in terms of access to ICT for Irish citizens. Certainly jobs were lost and gainful employment was difficult to come by, but on a day-to-day basis, people in Ireland still had access to the same advanced technology as they did before the companies left. That said, there was likely less disposable income for people to keep up with the latest technology because many were out of work. Likewise, the government probably had other priorities in the wake of the financial crisis than allocating funding toward improving ICT in schools, for example. But for me and others in Ireland at that time, there was not really a perceptible difference in ICT access. In fact, the ICT I encounter whenever I am in Ireland is always very comparable to what we have here! [Code at New-info response]

Below is the example of the **N-loop** response chain from the **PGC**:

Student 3:

Student 6,

First of all, I really appreciate all of the information that you share in these discussions. Thank you!

Regarding the School of Engineering and their attempt at online instruction, I find it quite interesting that this group struggled with the technology. This is a group that I would have suspected would have breezed through the technology side of a streamed lecture.

I agree that the Swedish video makes going to class seem effortless. Both the lecturer and the student seemed at ease in their environment. Relating this to your experience with the medical appointment, how was the tone? Was technology a hurdle? It seemed that it was viewed as an advantage to both the doctor and patient. [Code at New-info response]

Student 6:

Student 3,

The tone of the medical appointment was very open, genuine, trusting. Since the technology was handled by the center and had been funded through a large grant, technology wasn't an issue. Part of the problem they were trying to solve was the lack of connectivity, broadband or wifi, where the patient lived. The center got upgrades and used cable and the coverage was as expected. As Student 9 mentioned last week, there are areas in the U.S. where connection continues to be an issue. [Code at New-info response]

Below is the example of the **B-loop** from the **NGC**.

Student 23:

As I was reading the article, I was surprised to see how many people, particularly those in rural areas, did not have a telephone. I wondered whether this was due to lack of financial resources or because a telephone was not wanted in the household. I assume that people in rural areas, who may not have friends or family in very close proximity, may prefer to have a telephone if they have the means to do so. Obviously that assumption is informed by my frame of reference and lifestyle as an American with financial means. I would be curious to know the actual reasoning behind the lack of telephone use in Paraguay. Depending on whether it is due to finances or personal choice, there are different implications for ICT development and people hoping to enhance ICT in that country. [Code at Building-on response]

Student 26:

Student 23,

You bring up a good point that I did not think about. I just assumed that the people did not have telephones because they didn't have the money, which could be the case, but I did not think about maybe they do not want them. I would assume because of the amount of people without telephones, it is most likely because they don't have the money for one. In the beginning of the article they talk about how in rural areas a lot of the families are units, and I know this to be true even in some parts of our country. Maybe this could play a role? Because everyone lives with their families, even extended families, there isn't a need for a telephone? [Code at Building-on response]

Below is the example of the **B-loop** from the **NGC**.

Student 2:

I agree with S3, that negative news gets more response than positive. I liked how the article was labeled "Clickbait" and talked about how the media and general population may not be getting the whole story and this has a harmful effect. This is something we see happening today in many areas, not just education. Instruction is still (more) important, but why deny useful tools if they are used properly? The problem isn't the technology, it's trying to replace instruction with technology, and/or not knowing how to use the technology. [Code at Building-on response]

Student 5:

I also agree with S3, negative news get more attention than positive news. The reason is not that people dont see the good, its only because the negatives is what will effect the the education system and why not shine a light on a weakness? [Code at Building-on response]

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Vita

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EDUCATION

Doctor of Philosophy – Instructional Design, Development and Evaluation 2019
Syracuse University, Syracuse, NY
Advisor: Jing Lei, Ph.D., Professor, Department Chair, IDD&E
Dissertation Title: How does a gamification design influence students' interaction in an online course?

Master of Arts – Learning Sciences and Technology Design 2013
East China Normal University, Shanghai, China

Bachelor of Science – Computer Science 2010
Beijing Language and Culture University, Beijing, China

PUBLICATIONS

Refereed Publication

Chen, Y., Lei, J., & **Cheng, J.** (2019). What if online students take on the responsibility: Students' cognitive presence and peer facilitation techniques. *Online Learning*. 23(1), 37-61. doi:10.24059/olj.v23i1.1348

Non Referred Publication

Wang, Q., & **Cheng, J.** (2018). Research design and statistical modeling in contemplative meditation studies. In D. Grimes, Q. Wang. & H. Lin (Eds.), *Empirical Studies of Contemplative Practices* (43-86). New York: Nova Science Publishers, Inc.

Cheng, J., & Koszalka, T. A. (2016) Cognitive flexibility theory and its application to learning resources. Retrieved from: http://ridlr.syr.edu/wp-content/uploads/2016/09/CFT_FInal.pdf

Cheng, J., & Ren, Y. (2012) Creativity education: from instructionism to improvisation with structure --- An interview with Dr. Keith Sawyer. *China Educational Technology*, 32(1), 1-6

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Zhan, Y., **Cheng, J.**, Lin, L. Wang, T., Wang, Y., & Ren, Y. (2012) To know is not enough --- A review of AERA 2012. *Journal of Distance Education*, 212, 3-12

Conference Proceedings

Zhan, Y., **Cheng, J.**, Ren, Y., Yu, Q. (2011) To improve the TPACK of pre-service teachers through using a "learning by designing" method. CSCL Conference Proceedings Volume III Community events proceedings: Keynotes, symposia, practitioner-oriented events, pre-conference, and post-conference, Hong Kong, China, July 4–8, 2011.

Manuscripts Submitted to Peer Reviewed Journals

Wu, Y., **Cheng, J.,** & Koszalka, T, A. Transdisciplinary approach in middle school: A case study of co-teaching practices in STEAM Teams. Manuscript submitted to *Journal of Research in STEM Education*.

Manuscripts in Preparation

Cheng, J., Lei, J., & Zhang, L. The influence of gamification design on students' interaction in an online course. Manuscript in preparation.

Cheng, J., Zhang, L., & Lei, J. Assessing online academic discussion from knowledge building perspective: an exploratory case study. Manuscript in preparation.

Cheng, J., & Lei, J. Students' commenting behaviors in an online blogging activity.

Zhang, L., **Cheng, J**., & Lei, J. How the Anonymous Feature of Audience Response System Influences the Interactions of Students by Different Types of Questions.

CONFERENCE PRESENTATIONS

Cheng, J., Walton, A. (2019). A Design of an EdTech Pilot Simulation for Preservice Teachers. Poster presented at The Annual Convention of the Association for Educational Communications and Technology (AECT), Las Vegas, October 21–25, 2019

Cheng, J., Zhang, L., & Lei, J. (2019) Assessing Online Academic Discussion from a Knowledge Building Perspective: an Exploratory Case Study. Paper presented at the Annual Meeting of the American Educational Research Association (AERA), Toronto, April 5 - April 9, 2019

Cheng, J., Lei, J. & Zhang, L., (2019) The influence of gamification design on students' interaction in an online discussion forum. Paper presented at the Annual Meeting of the American Educational Research Association (AERA), Toronto, April 5 - April 9, 2019

Cheng, J., & Lei, J. (2018). Students' Interaction in a Gamified Online Course: A Comparison Analysis of Six Cases. Round Table presented at the Annual Meeting of the Association for Educational Communication and Technology (AECT), Kansas City, October 23 - 27, 2018

Zhang, L., **Cheng, J.**, & Lei, J. (2018). The Influence of Anonymous Feature of ARS on the Interactions of Students with Different Levels of Social Anxiousness. Round Table presented at the Annual Meeting of the Association for Educational Communication and Technology (AECT), Kansas City, October 23 - 27, 2018

Lei, J., Wang, Q., **Cheng, J.**, Yang, T., Yang, X. (2018) What Makes the Difference in Learning Outcomes in MOOCs: Results from a Meta-Analysis of Peer-Reviewed Empirical Studies. Paper presented at the Annual Meeting of the American Educational Research Association (AERA), New York April 13- April 17, 2018

Cheng, J., Lei, J., & Wilhelm-Chapin, M. (2017). Network Diagram as the Formative Feedback in an Online Blog Activity. Round table presented at The Annual Convention of the Association for Educational Communications and Technology (AECT), Jacksonville, November 7 - 11, 2017

Cheng, J. (2017). Students' Understanding and Use of In-Game Feedback in an Educational Simulation Game. Round table presented at The Annual Convention of the Association for Educational Communications and Technology (AECT), Jacksonville, November 7 - 11, 2017

Cheng, J., Lei, J., & Wilhelm-Chapin, M. (2017). Social Network Analysis of Student-Student Interaction in A Blog Activity of an Online Course. Poster presented at the Annual Meeting of the American Educational Research Association (AERA), San Antonio, April 27- May 1, 2017

Cheng, J., Wilhelm-Chapin, M., & Lei, J. (2016). Using Social Network Analysis to Investigate Student Social Presence Through Blogging Activities in an Online Course. Poster presented at The Annual Convention of the Association for Educational Communications and Technology (AECT), Las Vegas, Nevada, October 18-21, 2016.

Wang, M., **Cheng, J.**, Kim, H., Yang, X., Zhao, J., & Ren, Y. (2016). How Teachers Seek and Learn from Negative Feedback. Poster presented at the 12th International Conference of the Learning Sciences (ICLS), Singapore, June 20-24, 2016

Cheng, J., Wu, Y., & Koszalka, T. A. (2016). A Case Study of a Middle School's STEAM Practices to Promote 21st Century Skills. Poster presented at the Annual Meeting of the American Educational Research Association (AERA), Washington, D. C. April 8-12, 2016

Cheng, J. (2015). A Role-Play Board Game Prototype for Pre-service Teacher's Transition from Learning Setting to Working Setting. Poster presented at The Annual Convention of the Association for Educational Communications and Technology (AECT), Indianapolis, Indiana, November 3-7, 2015.

Chen, Y., Lei, J., & **Cheng, J.** (2014). Exploration of Learners' Cognitive Presence in an Inquiry-based Online Course: Evidence from Online Discussions. Paper presented at The Annual Convention of the Association for Educational Communications and Technology (AECT), Jacksonville, Florida, November 4-8, 2014.

Jin, Y., **Cheng, J.**, & Chen, X. (2012). Items Analysis for a Public Mathematics Test for Grade 9 Students in Shanghai. Paper Presented at International Forum on Achievement Assessment and Evaluation, November 2 – November 4, 2012, Shanghai, China

Zhao, J., Pei, X., Feng, R., **Cheng, J.**, & Jin, Y. (2012). Chinese Teacher Professional Practice and its effects on student Achievement: Based on Post PISA Survey in Five Cities. Paper Presented at the Annual Conference of the American Educational Research Association(AERA), Vancouver, British Columbia, Canada, April 13-17, 2012

TRANSLATION

Collins, A., & Halverson, R. (2013) *Rethinking Education in the Age of Technology: the Digital Revolution and Schooling in America* (J. Chen & **J. Cheng,** Trans.). Shanghai, China: East China Normal University Press. (Original work published 2009)

Nelson, B.C., & Erlandson B.E. (2015) *Design for Learning in Virtual Worlds* (G. Xu, **J. Cheng** & H. Zhang, Trans). Shanghai, China: East China Normal University Press. (Original work published 2012)

PROFESSIONAL EXPERIENCE

Graduate Assistant 2016 - 2017

Academic Integrity Office, Syracuse University, Syracuse, NY

- Redesigned and developed the online Academic Integrity Seminar in Blackboard
- Facilitated and graded the online Academic Integrity Seminar (9 sessions)
- Provided face-to-face meetings considering the seminar when students needed
- Analyzed evaluation data collected from students and created evaluation reports

Marketplace Quantitative Research Intern 2016

Program and Product Evaluation Division, Digital Promise, San Mateo, CA

- Cleaned and analyzed data of students' performance test and learning application log data for the organization's technology integration project
- Contributed to the final evaluation reports

UNIVERSITY TEACHING EXPERIENCE

Instructor of Record 2017 - 2019

Instructional Design, Development and Evaluation, Syracuse University, Syracuse, NY

Undergraduate Course: Integrating Technology into Instruction I, II, III Course Series Instructor

- IDE 401 Integrating Technology into instruction III (Senior-level course)
    - Independently taught 3 semesters (5 sessions)
    - Co-taught 2 semesters with a fellow instructor (2 sessions)
    - Proposed a virtual session to accommodate students' field placement schedule
    - Developed a course project of building an EdTech showcase portfolio
    - Developed activities that focused on evaluating technology tools
    - Introduced iPad and Google Cardboard to the curriculum

Teaching Assistant 2015 - 2018

Instructional Design, Development and Evaluation, Syracuse University, Syracuse, NY

Awarded **the Certificate in University Teaching** for successful completion of a professional development series, faculty mentored teaching experience, and presentation of teaching portfolio to peers and faculty.

Graduate Education Course Teaching Assistant

- IDE 611 Technology for Instructional Settings
    - Teaching Assistant for 3 semesters
    - Redesigned two course modules
    - Monitored students' performance in the blog project
    - Assisted students to build blogs in various blog providers
    - Created network diagram feedback for students
- IDE 772 Educational Technology in International Settings
    - Teaching Assistant for 2 semesters
    - Redesigned the course to include gamification

GRANTS

Research and Creative Grant ($989) 2018

School of Education, Syracuse University

IDD&E Professional Development Fund Travel Grant ($1,600) 2015 - 2018

IDD&E Department, School of Education, Syracuse University

Graduate Student Travel Grant ($1,600) 2015 - 2018

School of Education, Syracuse University

Graduate Students Organization Travel Grant ($950) 2016, 2019

Graduate Student Organization, Syracuse University

HONORS and AWARDS

Summer Dissertation Fellowship 2019

Graduate School, Syracuse University

Certificate in University Teaching 2017

Graduate School Future Professoriate Program, Syracuse University

Design and Development Competition Semi-finalist 2017

Association for Educational Communications and Technology (AECT)

Syracuse University Fellowship 2013 – 2016

Syracuse University

William L. Millard Instructional Technology Graduate Scholarship 2015

School of Education, Syracuse University

National Scholarship for Graduate Students 2012

East China Normal University

SERVICE

UNIVERSITY

School of Education International Students Peer Mentor 2017 - 2018

IDD&E Department Orientation Committee Chair & Co-chair 2015, 2017

School of Education Teaching Review Committee Member 2015 - 2016

IDD&E Department Marketing Team 2013 - 2016

School of Education Tenure and Promotion Committee Student Representative 2014 - 2015

IDD&E Department Newsletter Editor 2013 - 2015

PROFESSIONAL

Proposal reviewer for AECT	2018 - 2019
Proposal reviewer for AERA	2018
Student volunteer at AECT's annual convention	2014

PROFESSIONAL MEMBERSHIPS

Association for Educational Communications and Technology (AECT)	2014 - Present
American Educational Research Association (AERA)	2015 - Present