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How Do Students Interact in Online Discussion Forums in a PENS-Based Gamified Course?

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This study explored how to effectively apply gamification design principles to improve the quantity and quality of online discussions. Based on a game design framework: Playing Experience of Needs Satisfaction (PENS), two specific gamification design principles, (1) aligning gamification awards with specific performance expectations and (2) weighing gamification awards based on task challenging levels, were applied in online discussion forums of a graduate level online course. Data on student activities in online discussion were collected from the baseline (non-gamified) version of the course and the gamified version. Both quantitative and qualitative methods were used to examine how students interacted with each other in the gamified environment compared to non-gamified environment. Results suggested that the gamification design features promoted knowledge-building in online discussions, encouraged more decentralized and diverse interactions among students, and motivated a higher level engagement in student facilitators. Implications for further research and practices were also discussed.
Key words: Gamification; Online discussion; Student-student interaction; Playing Experience of Needs Satisfaction

INTRODUCTION

A motivational design can make quality instruction more appealing to students (Keller, 2009). Video games are commonly believed to have huge appeal and engage players in the long term (Ryan et al., 2006). Over the past two decades, educational and psychological

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researchers have studied the motivation mechanism in video games and discussed its educational values and potential (Gee, 2003; Habgood & Ainsworth, 2011; Dickey, 2007). However, the cost and expertise required of designing and developing an educational game is daunting, therefore, researchers have turned to gamification design, a type of motivational design that maintains users' loyalty in business field (Huotari & Hamari, 2012) and has shown its capacity and potential in educational settings (Caponetto et al., 2014). Instead of developing a whole new educational game, gamification uses game elements in a non-game context (Deterding et al., 2011). It adopts game design elements to provide users game-like and social experiences to affect users' motivation of the expected behaviors (Hamari & Koivisto, 2013). Some learning management systems have included gamification elements, such as badges in Blackboard, which makes the use of gamification become attainable for many educators.

In higher education online programs, gamification studies showed positive results in terms of direct engagement and related learning outcomes (Looyestyn et al., 2017). However, although empirical studies on the design of the widely used gamification elements have mushroomed in recent years, these gamification elements have many variations, and their effectiveness are not guaranteed without a careful design for the specific context. To address this issue, this study proposed and applied two gamification design principles based on the Playing Experience of Needs Satisfaction (PENS) in an online discussion forum of a graduate level course to examine student interaction in the gamified course compared to the non-gamified version.

MIXED RESULTS OF GAMIFICATION STUDIES IN EDUCATIONAL FIELD

Gamification, "the use of game design elements in non-game contexts" (Deterding et al., 2011, p.2), was first proposed in 2002 by Tulloch (2004). Gamification design has been used since to "improve and increase" the target audience's "motivation/engagement" to enhance learning in various educational settings (Caponetto et al., 2014, p. 53; Brigham, 2015). Theoretically, gamification could positively affect student learning. Landers (2015) claimed that gamification could be considered an add-on to the instruction: it is one approach to make pre-existing instruction more appealing. Therefore, the selected game elements should incite changes in student's behaviors and attitudes which could eventually influence learning outcomes.

However, given various design of the gamification elements, results from empirical studies have been mixed. On the one hand, successful gamification design often reinforces performance expectations with points, badges, and a leaderboard. For example, Çakıroğlu and colleagues (2017) added gamification elements to a face-to-face Information and Communication Technology (ICT) course for preservice teachers, such as points awarded to students who answered the questions correctly in the class. Students at the top of the leaderboard were given chances to perform the role of the teacher. Tsay and colleagues (2018) also identified positive results when implementing gamification design including a leaderboard and four different types of badges in a college level course. Ding and her colleagues (2017, 2018, 2019) created a gamified online discussion tool and implemented it in multiple settings with positive results on cognitive, behavioral and emotional engagement. Their online discussion tools included basic discussion board features and gamification features, such as badges, points, leaderboard, progress bar, and awards.

On the other hand, however, the use of these gamification elements did not always guarantee successful results. For example, Kyewski and Krämer's (2018) study compared the effectiveness of badges on motivation and performance but did not find any significant impact on either outcomes. Hanus and Fox (2015) compared students' motivation and performance in a gamified course with a non-gamified course. Badges were embedded in the gamified course. The results showed the motivation and performance of students in the

gamified course decreased over time. Moreover, the final exam score in the gamified course was lower than the non-gamified one.

In summary, although the gamification elements used in most gamification studies shared the same names such as points, badges, and leaderboard, the effectiveness of these elements was inconclusive due to the multifarious ways of design and delivery. Therefore, empirical studies focusing on gamification design principles are still needed to guide the future use of gamification elements in educational settings.

ADOPTING PLAYING EXPERIENCE OF NEEDS SATISFACTION (PENS) IN EDUCATIONAL SETTINGS

Research on games' motivation mechanism (Ryanet al., 2006) shed light on how to design gamification elements to fit in a specific educational setting. Using Self-Determination Theory as the analytic framework, Ryan and colleagues (2006) investigated participants' playing experience in terms of needs satisfaction in different games. They found that when a game design fulfilled participants' three basic psychological needs—Autonomy, Competence, and Relatedness—the game engaged participants in the long term. Rigby and Ryan (2011) further proposed a game design framework: Playing Experience of Needs Satisfaction (PENS).

This study focused on adapting the Competence needs design principles in PENS for educational settings. Competence referred to "the intrinsic need to feel a sense of mastery or effectance in what one is doing" (Rigby & Ryan, 2007, p. 5). Rigby and Ryan (2011) described three conditions for competence needs satisfaction in games. First, a player should be clear about what the game task is and what the success state looks like. Second, the player should believe they can and will eventually win the task. Third, the player should receive clear feedback based upon their actions. Thus, when the player succeeds, they could feel a strong sense of ability which generates competence needs satisfaction. To fulfill the three conditions, a game should provide the player a well-defined goal, a challenging but not overwhelming task, and timely performance feedback. When the three elements work together, they create a mastery feedback loop that provides consistent competence needs satisfaction and glues players to the game.

Considering competence needs satisfaction in educational settings, the three elements that create a mastery feedback loop are not novelties to educators. However, these elements are not always explicit to students. For example, Peters and Hewitt (2010) found students often felt uncertain about their performance in online discussion activities. If students did not know whether they reached the expectations or not, they could hardly feel mastery. The purpose of the gamification elements is to bring students competence needs satisfaction when they complete the learning activity. To fulfill the purpose, the typical gamification elements (various types of awards such as badges and points) should convey students the information regarding the performance expectation and the challenging level of the learning task. In this way, students could know what the task is and how difficult it is in comparison to their ability. After the task completion, by receiving the awards, students know that they have "won" the task in the courses.

Therefore, this study proposed two gamification design principles, (1) the awards in the gamification design should be aligned with the performance expectations in the course activities and (2) the awards should be weighted based on how challenging the tasks are. When applying the two principles in a course, the performance expectations and the challenging tasks should be centered on learning behaviors that lead to a meaningful learning experience. In this study, the two gamification design principles were applied in an online discussion activity. The next section presents factors that contribute to a knowledge-building discussion based on previous research on student-student interaction

in online discussion forums. Thus, the specific gamification design in the current study focused on these aspects.

STUDENT-STUDENT INTERACTION IN ONLINE DISCUSSION FORUMS

Online discussion as a popular interaction platform provides opportunities for students to articulate and exchange ideas (Bain, 2011; Hou, 2012). From a knowledge-building perspective, characteristics of a successful academic online discussion include an open and decentralized participation and a focus on in-depth understanding (Scardamalia & Bereiter, 1994). Particularly, a centralized interaction pattern could turn a group discussion into few individuals' presentations. For example, "keeners," who quickly and constantly interact with peers and often dominate the discussion (Romiszowski & Mason, 2004; Phirangee et al., 2016), may inhibit the information flow. Besides bringing various perspectives on the topics being discussed, students with different understanding levels could also point out the inadequacies of explanation in peers' messages and push the conversation towards clarification. In addition to a decentralized interaction pattern, the quality of the messages posted in the discussion also matters. Posting agreement and compliment messages which contain limited substance was concerned by educators because students could be used to the superficial collaborative work without any "genuine collaboration" (Peters & Hewitt, 2010, p. 959). As described in the Interaction Analysis Model (IAM, Gunawardena et al., 1997), it was through meaning negotiating that discussion participants contribute knowledge to reach a common understanding as a group. Simply sharing information or showing agreement resulted in only surface-level thinking for the group (Hew, Cheung & Ng, 2010).

Assigning student facilitators is a frequently used design in online discussion studies (e.g., Xie et al., 2014; Zha & Ottendorfer's, 2011). The role of student facilitator usually shares the instructors' responsibilities of initiating discussion questions and providing responses with students. It allows students to take the initiative in online discussions (Chen et al., 2019). To maintain an active and productive discussion thread, student facilitators are demanded more time and effort in comparison with being a responder. Therefore, being a successful student facilitator could be considered as a challenging task in online discussion activities.

In summary, to achieve knowledge-building in online discussion forums, broad and in-depth idea exchanges are expected to happen among students. Furthermore, a successful facilitator actively facilitates and maintain the developing of the discussion, which is an intentional endeavor and a challenging task for a discussion activity.

The study investigated student interaction in online discussion forums in two versions of a graduate level course, one without gamification and one with the gamification design based the two gamification design principles according to PENS. Using student interaction in the non-gamified course as a baseline, two hypotheses were proposed: (1) when the gamification design awards broad peer interacting and quality messages in the discussion forums, student interaction should present a decentralized pattern and substantial meaning exchanges; (2) when the gamification design assigns higher-level awards on facilitation work, the student facilitator should be active in keeping the development of the online discussion.

METHODS

RESEARCH SETTING AND PARTICIPANTS

This study used convenience sampling and the site was a private university in the United States. The course we applied the two gamification design principles was a three-

credit asynchronous online course about educational technology for graduate students. The course lasted for six weeks in summer, using Blackboard as the learning management system. 24 students enrolled in the non-gamified version of the course in 2016 summer. They were divided in two concurrent sections of the course and students interacted with peers in the same section. 14 students enrolled in the gamified version of the course in 2017 summer. One student was excluded from each of the course due to incompletion of the course. As presents in Table 1, the majority of the participants in both courses were U.S. citizens enrolled in a master program of education. The course was taught by the same instructor in both years.

Table 1. *Basic Demographic Information of the Participants*

	Non-Gamification Course (2016)	Prototype Gamification Course (2017)
N of Participants	23	13
N of International Students	5	2
N of Doctoral Students	2	3

INTERVENTION DESIGN

Non-Gamified Course Design. Student interaction in the non-gamified course in 2016 was used as the base line. The non-gamified course included two major activities, weekly online discussions and a writing project. Students were required to post at least one original message and one comment in each discussion thread (there were 38 threads in total in the two sessions of the non-gamified course). Except the first two weeks where the instructor facilitated the online discussion, students acted as discussion facilitators in the other four weeks. In each week, the designated student facilitators were required to work with the course instructor to decide the readings, to initiate discussion questions, and to facilitate discussions through the week.

PENS-based Gamified Course Design. As aforementioned, the gamification design in this study followed two design principles adapted from the PENS framework: the awards were aligned with the performance expectation and were weighted according to how challenging the tasks were. In the gamification version of the course, different types of the awards were added to the same two major course activities as in the non-gamification course. These awards aimed at bringing an active and decentralized participation with quality messages in the discussion forum. Figure 1 presents the gamification design for the online discussion forums, and Figure 2 (see next page) presents some gamification elements in the Blackboard.

The awards included badges and points. Three types of badges were provided, which were aligned with the two online discussion performance expectations. First, to encourage quality messages, a “best speech badge” was awarded to peer-evaluated best message in each week. The winner of each week was selected based on the results from the rating system embedded in the Blackboard discussion forum. Second, to encourage students to interact with various peers, the “resourceful badge” was awarded to students who responded to the greatest number of classmates, and the “incentive badge” was awarded to students who received replies from the greatest number of classmates. Facilitators of the week were excluded from the three badges.

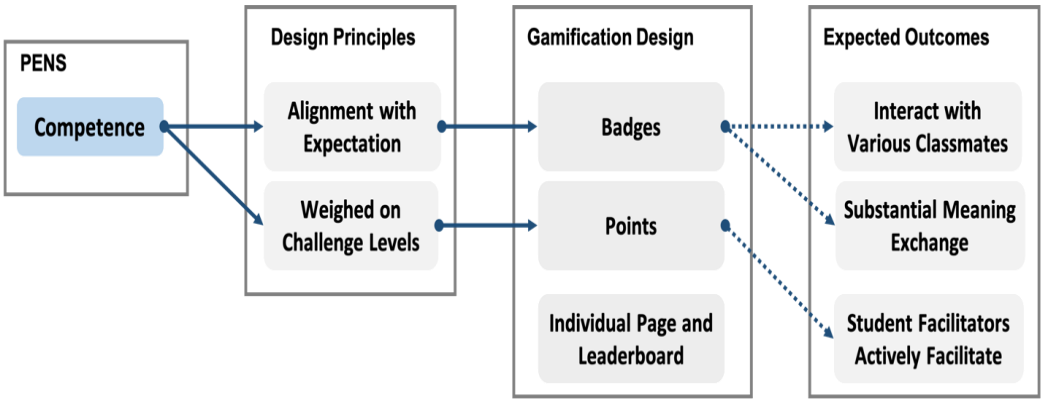

Figure 1. Intervention design in the gamified course.

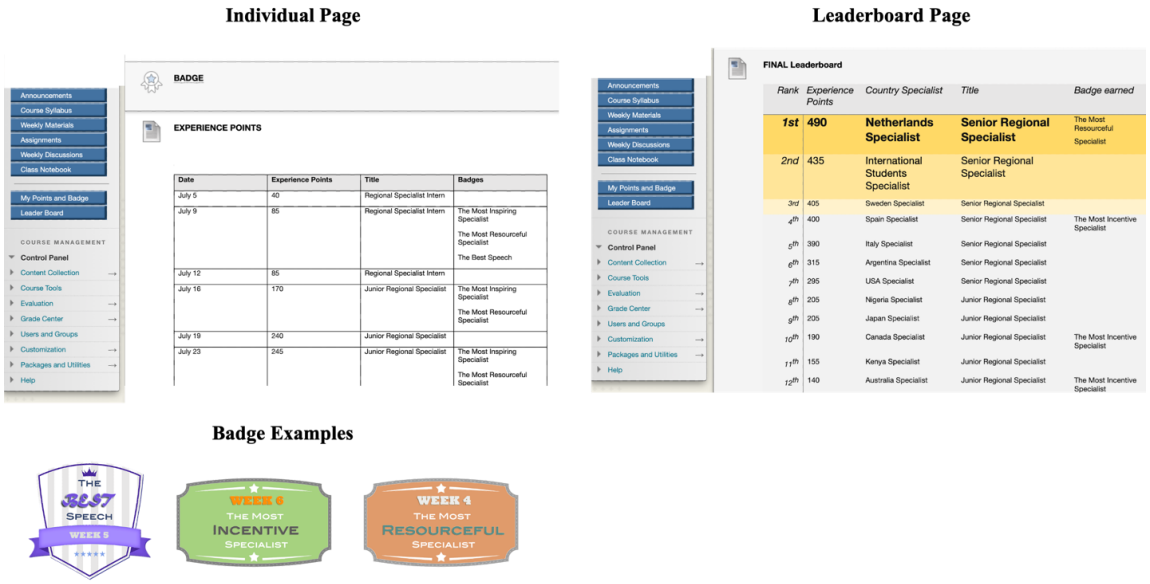

Figure 2. Screenshots from the blackboard in the gamified course (the Badges that students won would be displayed in the BADGE section. This screenshot was from an instructor account so there were no badges displayed) and badge examples.

The point value for each learning related behavior was weighted on the estimated effort needed. Regular experience points were given to students when they participated in course activities. Bonus experience points were awarded for students' extra efforts. Particularly, the facilitator bonus was 10 times value of posting a message since successful facilitation was a challenging task. The bonus was only awarded to student facilitators when the total number of the messages in the thread they facilitated reached to a certain number. Students' accumulated experience points at the end of the course decided students' final participation points in the course grade.

Each student could access their own points, badges in a designated section in the Blackboard throughout the semester. There was also a leaderboard presenting the latest badges winners and the accumulated experiences points of each student under a code name based on students' writing projects.

DATA COLLECTION

The data used in this research included course log data generated by the Blackboard system, and students' messages posted in the discussion forum. Course log data was downloaded every day for the duration of the course to determine the points and badges. The overall course log data was downloaded again when the course ended. The two files were compared to ensure their accuracy. The daily interaction data in the discussion forum was documented by the first author manually including the reply structure and the content of each message. We excluded the interaction between the instructor and students and messages posted in the self-introduction threads and the general question threads, since the focus of the study was academic discussions among students.

DATA ANALYSIS

We used a combination of quantitative and qualitative research methods and analysis software to process the raw data into different forms and then conducted statistical analyses accordingly. For the first hypothesis, to examine student interaction in the two versions of the course, we investigated: (1) interaction pattern, by using degree, density, and centralization measures from Social Network Analysis (SNA), and then compared them by using Mann-Whitney Test (semester degree data); (2) interaction quality, by first categorizing the responses from a knowledge-building perspective, and then abstracting the patterns of two-response chains using Lag Sequential Analysis (LSA). For the second hypothesis, to examine the activity levels of the student facilitators, we compared the number of messages and the number of each type of responses via Multiple Regression Analysis. Gephi 0.9.2 was used for SNA. MAXQDA was used for coding the discussion transcripts. SPSS 26 was used for the statistical analysis. LSA was conducted in Excel following the procedures and equations in Bakeman and Gottman (1997).

Social Network Analysis Measures for Interaction Distribution. Social Network Analysis (SNA) was employed to process relational data of students' posting behaviors in online discussion forums. To elaborate on the interactions among students, in-degree, out-degree, density, and centralization measures were calculated and compared.

In-degree was the measure of the variety of repliers that a student had over a certain period, which was the number of distinct peers that a given student received comments from. Out-degree was the measure of the broadness of the student's interactions, which was the number of distinct peers that a given student left comments on. In-degree and out-degree were calculated for each student in each week and in the semester. To compare the in-degree and out-degree between the two versions of the courses, a variable that represented the percentage of peers that a student had interacted with in the course (Freeman, 1979) was calculated for each degree measure. For example, an in-degree of 0.5 represents a student received messages from 50% of classmates (other than him/herself) in the section, and an out-degree of 0.3 represents a student sent messages to 30% of the of classmates (other than him/herself) in the section.

Density represented the connectedness of the network. Density was calculated as the actual number of links (directed from Gephi) of two students presented in the network, divided by the maximum possible links in the network (Prell, 2012). A density of 0.2 indicates among all the possible student pairs, 20% of them had connection.

Centralization scores (C_D) described the whole group centrality, and were calculated by using the degree measures via the following equation (Freeman, 1979, p. 229):

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

*1. C_D represents the degree-based centralization score at the group level. The Subscript D was used in Freeman (1979) to differentiate from other types centralization score, such as betweenness-based (C_B). $C_D(p_i)$ represents the degree value for a student (at the individual level), and i stands for any student in the group with n students in total. $C_D(p^*)$ represents the max degree value for the student (who had the most connections) in the group. The numerator is the sum of the actual differences in the group while the denominator is the maximum sum of differences in the group.

In the equation, the numerator was the sum of the differences of the largest degree of a student ($C_D(p^*)$) to the degree of other students ($C_D(p_i)$). The denominator was the maximum sum of differences in a network of n students. Density and centralization scores were calculated in a semester scale.

Interaction Analysis Model (IAM) for Message Quality. To examine the interaction quality, the discussion transcripts were coded based on IAM. The unit of analysis was one response rather than one message. For example, Student A replied to two peers respectively in one message, this message contained two responses. Student A's message to one peer included two unrelated topics, this message was also considered as containing two responses.

The IAM is a commonly used instrument for analyzing online discussion (Lucas et al., 2014), which proposed a 5-Phase model to describe the knowledge building process in computer mediated communication. All the transcripts of students' interaction in the discussion forums were coded into 21 types following the IAM (Gunawardena et al., 1997) by two researchers. To compare the interaction quality with a focus on knowledge building, we regrouped the original 21 sub-categories in IAM into four categories: Initial response (I), Paraphrase response (P), New-info response (N), and Building-on response (B). An Initial response is a direct statement to the discussion questions; a Paraphrase response is an agreement statement; a New-info response includes adding new examples to a statement and asking and answering questions related to a statement; a Building-on response includes the original IAM's Phase 2 to 5 (exploration of inconsistency among ideas, negotiation, modification, and agreement of the new constructed ideas) (Hew & Cheung, 2011). Furthermore, we added a category for non-academic responses which included appreciation and off-task conversation. The coding scheme and examples were in the appendix.

A second coder coded 30% of data, which was randomly selected from the two courses. The interrater reliability (Kappa) was calculated in MAXQDA. The interrater reliability was 0.57 for the gamified course and 0.63 for the non-gamified course. Through multiple in-depth discussions, the two coders reached 100% agreements eventually. Overall, the interrater reliabilities were slightly lower than other studies used IAM (e.g., 0.67 in Yücel & Usluel, 2016; 0.669 in Goggins et al., 2016).

Lag Sequential Analysis. Lag Sequential Analysis (LSA) was used to explore the class-level interaction in online discussion forums. LSA focused on the patterns of two-event chains in a giving context (Bakeman & Gottman, 1997). In the study, an event was a response. The transitional probability was the probability, given a type A response, of the type B response occurring immediately after. To identify which transitional probabilities were significantly different from the expected value, the adjusted residual (z score) for each two-response chains was 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), a z score greater than 1.96 indicated the two-response chain reached the significant level ($p < 0.05$).

Multiple Regression Analysis. To examine the effect of facilitator bonus experience points, the interaction item of gamification condition and facilitator status was added into

the regression model of quantity and responses types for the last four weeks. In all regression models, week was coded from Week 1 to Week 6 as 1 to 6. Gamification condition was the independent variable with 0 as the non-gamified course, and 1 as the gamified course.

FINDINGS

To examine whether the gamification design brought knowledge building features to interaction among students, we compared SNA measures, two-response chain types, and facilitator involvement in the gamified course and the non-gamified course. Except the self-introduction threads and the general question threads, there were 557 messages posted by 13 students in the gamified course during the six-week period, and 675 messages from 23 students in the non-gamified course.

DISCUSSION IN THE GAMIFIED COURSES PRESENTED KNOWLEDGE-BUILDING FEATURES

By comparing the SNA measures in the two versions of the course, we found that student interaction in the gamified course was more decentralized than the non-gamified course. They interacted with more various peers over the six-week course even though students in both courses interacted with similar proportion of students in each week. Moreover, the New-info response was more frequently present in the significant two-response chains in the gamified course in comparison with non-gamified course. This indicated that students in the gamified course frequently contributed new information to the discussion threads and the messages contained new information were also further developed by peers.

Gamified Course Student Received More Various Repliers over the Semester. The in-degree represented the proportion of classmates who sent messages to a given student. A higher in-degree indicated this students' messages attracted more classmates to comment on. Out-degree referred to the proportion of classmates whom a given student sent messages to. A higher out-degree value indicated the student actively reached out to more peers. As shown in Table 2, students in the gamified course had higher in-degree and out-degree values in most of the weeks.

Table 2. *Descriptive Statistics for In-Degree and Out-Degree in Each Week in the Non-Gamified Course (Non-GC) (N=23) and Gamified Course (GC) (N=13)*

			W1	W2	W3	W4	W5	W6
In-Degree	GC	Mean	0.115	0.242	0.467	0.391	0.411	0.224
		SD	0.129	0.151	0.286	0.261	0.262	0.251
	Non-GC	Mean	0.076	0.169	0.321	0.397	0.334	0.317
		SD	0.114	0.143	0.261	0.243	0.284	0.283
Out-Degree	GC	Mean	0.115	0.243	0.467	0.391	0.410	0.225
		SD	0.151	0.186	0.185	0.209	0.23	0.12
	Non-GC	Mean	0.076	0.169	0.321	0.397	0.334	0.316
		SD	0.108	0.173	0.237	0.251	0.240	0.213

Since the semester in-degree and out-degree did not satisfy the normality assumption, a nonparametric analysis, the Mann-Whitney test, was used to compare the differences.

The results showed in the gamified course, the comments each student received were from more classmates compared to the non-gamified course (U = 76, p = .015), however each student responded to a similar proportion of peers over the six weeks in both courses (U = 96.5, p = .077). This non-symmetric result meant that most non-gamified course students sent messages to only a few certain classmates over the semester, while most students in gamified course sent messages to different classmates over the semester.

Moreover, the gamified course had a higher density score (.885) than the non-gamified course (.763), with a lower centralization score (0.06 of the gamified course; 0.11 of the non-gamified course) on the semester scale. This result resonated with the semester degree comparison result, indicating that more links between students existed in the gamified course, and the distribution of the links was more even and decentralized than the non-gamified course.

Overall, the interaction pattern of the two courses was similar in each week. However, over the semester, the student interaction of the non-gamified course was centralized on several students, while student interaction of the gamified course was more evenly distributed among students.

Discussion in the Gamified Course was Maintained by Posing New-Info Responses. In this section, we compared the quality aspect of the online discussions. LSA for each week was conducted in both courses. The significant two-response chains were presented in Table 3. In the first two weeks, there were fewer students' interactions in both courses, resulting in limited significant two-response chains. In the last four weeks, in both courses the students actively replied to the Initial responses. In the gamified course, in addition to the Initial responses, the significate chains also started with other types of responses, while in the non-gamified course, most significant chains started with the Initial responses. This indicated that the initial ideas were further developed in the gamified course.

Table 3. *The Significant Two-Response Chains Which Occurred More Than Five Times in Each Week (The transitional probability is in the brackets)*

	Gamified Course		Non-Gamified Course	
Week 1	-		-	
Week 2	-		I→N	(26%)
Week 3	I→P	(21%)	I→N	(30%)
	P→B	(84%)	N→N	(63%)
	I→N	(40%)	I→B	(48%)
	N→B	(55%)		
Week 4	I→B	(41%)	I→P	(33%)
	B→N	(53%)	I→N	(37%)
			I→B	(26%)
Week 5	I→N	(52%)	I→P	(35%)
	N→B	(50%)	I→B	(44%)
	B→B	(46%)	B→N	(50%)
Week 6	I→N	(47%)	I→P	(27%)
			I→N	(25%)
			I→B	(47%)
			B→B	(60%)

Different types of responses showed different patterns in the gamified course than in the non-gamified course. The Initial response more often led to the New-info response in the gamified course. On the contrary, in the non-gamified course, students more often used the Paraphrase response and the Building-on response to reply to the Initial response. For the New-info response, in the gamified course, it led to the Building-on response

significantly in two weeks. However, in the non-gamified course, there is no significant N->B chain but a N-loop in one week. For Building-on responses, in both courses, there was one occurrence of B->N response chain and one B-loop in one week.

In sum, the significant two-response chains in the gamified course indicated the development of the initial ideas, however, the types of the two-response chains in both courses were mostly similar. In the gamified course, the significant two-response chains usually involved New-info response as either the source or target response, which indicated that the discussion was developed by introducing additional examples or questions. Additionally, compared to the gamified courses, the Initial response in the non-gamified course was more likely to be replied by the Paraphrase response which usually contain limited substance.

STUDENT FACILITATORS IN THE GAMIFIED COURSE ACTIVELY FACILITATED THE ONLINE DISCUSSIONS

The gamified course had the same student facilitators design as in the non-gamified course but added a high-value bonus points item to award active facilitation. To contrast the facilitator involvement in the two versions of the course, Multiple Regression Analysis was conducted to compare the number of messages the facilitators posted and the type of responses they used when facilitating discussions. As shown in Table 4, the interaction item of gamification condition and facilitator status presented a positive influence on the number of messages, Paraphrase responses, and New-info responses posted in each week, respectively. Overall, students in the gamified course posted significantly more Building-on responses than their counterpart in the non-gamified course. In both courses the facilitators posted more Building-on responses than other students.

Table 4. *Multiple Regression Analysis Summary Explaining Number of Messages, Paraphrase responses, New-info responses, and Building-on responses posted in the week from Gamification Condition, and the Interaction of Gamification Condition and Facilitator Status, when Controlling for the Number of Thread in the week, Facilitator Status, and Week (N=144)*

	Messages quantity		Paraphrase response		New-info response		Building-on response	
	B	SE	B	SE	B	SE	B	SE
Intercepts	-0.422	2.514	-0.26	0.612	-0.028	0.949	-0.366	1.136
N of thread	1.806***	0.443	0.286**	0.108	0.401*	0.167	0.583**	0.2
Facilitator	0.985	1.268	0.233	0.309	1.217*	0.479	0.837**	0.457
Week	-0.092	0.394	0.027	0.096	-0.133	0.149	-0.09	0.178
Gamification	0.731	1.044	-0.402	0.254	0.473	0.394	0.963*	0.412
Interaction	6.523**	2.086	1.389**	0.508	2.938***	0.787		
R squared	0.284		0.16***		0.366***		0.142***	

*p < .05. **p < .01. ***p<0.001.

Next, separate Multiple Regression Analyses were conducted for each course to examine the effect of being a facilitator. The model summary was in Table 5. In the gamified course, the facilitators posted significantly more messages than non-facilitator students. But in the non-gamified course, there was no significant difference between the facilitators and non-facilitator students. Meanwhile, the gamified course facilitators posted significantly more Paraphrase responses than non-facilitator students. Facilitators in both courses posted significantly more New-info responses than other students. Particularly, the gamified course facilitators posted significant more New-info responses than the non-gamified course facilitators, since the value of 4.094 did not fall within the 95% confidence interval (0.648 to 1.813) for the coefficient for the non-gamified course students (1.231).

Table 5. *Multiple Regression Analysis Summaries for Explaining Number of Messages, Paraphrase responses, New-info responses Posted in the Week from Facilitator Status, when Controlling for the Number of threads, Week in the non-gamified course (N = 92) and gamified course (N=52) Separately*

	Messages quantity		Paraphrase response		New-info response	
	Non-gamified	Gamified	Non-gamified	Gamified	Non-gamified	Gamified
	B (S.E.)	B (S.E.)	B (S.E,)	B (S.E.)	B (S.E.)	B (S.E.)
Intercepts	0.068	-0.458	-0.549	0.04	-0.082	0.722
	(2.349)	(6.227)	(0.69)	(1.274)	(0.687)	(2.646)
N of thread	1.419**	2.238*	0.328*	0.202	0.301*	0.485
	(0.461)	(0.92)	(0.135)	(0.188)	(0.135)	(0.391)
Week	0.066	-0.246	0.063	-0.064	-0.052	-0.256
	(0.381)	(0.916)	(0.112)	(0.187)	(0.111)	(0.389)
Facilitator	1.056	7.313**	0.219	1.629**	1.231***	4.094***
	(1.002)	(2.189)	(0.294)	(0.448)	(0.293)	(0.93)
R squared	0.115*	0.314***	0.074	0.26**	0.223***	0.345***

*p < .05. **p < .01. ***p<0.001.

According to the results, the gamified course facilitators were more actively involved in the discussion than the non-gamified course facilitators. Particularly, they often posted new-info responses to maintain the discussion. The results resonated with the LSA results that in the gamified courses, the Initial response was often replied with the New-info response, and the New-info response led to the Building-on response. Therefore, the active participation of the facilitator contributed to the quality of the online discussion. Contrasted with the gamified course facilitator, the non-gamified course facilitators used similar strategies: posting the New-info response. However, these responses did not often lead to the Building-on responses.

DISCUSSION

The gamification design in the study followed two design principles that were based on PENS (Rigby & Ryan, 2007, 2011). Student interaction in discussion forums of the gamified course was examined and compared to the non-gamified course. The findings showed that in comparison to the non-gamified course, student interaction in the gamified course was more evenly distributed among the peers over the six weeks. The development of the discussion threads in the gamified course was more often via the New-info response and less likely to be followed by the Paraphrase response. Finally, the gamified course student facilitators actively replied to other students by using New-info responses to keep the discussion growing. Overall, student interaction in the discussion forum presented a more decentralized interaction pattern and the student facilitators were more active in comparison with the non-gamified course.

THE EFFECTIVENESS OF THE GAMIFICATION DESIGN ON STUDENT INTERACTION

Aligning the Gamification Elements with the Performance Expectations. Awards in a gamification design should depend on the performance expectations in the course, thus receiving awards could make students feel being recognized due to their efforts in completing the tasks. Using awards to make the performance expectations explicit to students helps the formation of a mastery feedback loop (Rigby & Ryan, 2011) that provides students competence satisfaction. For the online discussion forums in this study, students were expected to interact with as many peers as possible to create a decentralized discussion for knowledge building (Scardamalia & Bereiter, 1994). Therefore, the two

badges (incentive and resourceful) were designed to encourage students to communicate with various peers. These badges set performance expectations for students and made them aware of the expected learning behaviors in the discussion activity. Similarly, the quality badge in the course reminded students that they should not compromise quality for quantity. A gamification design should first identify the expected learning behaviors in the course and then create the awards accordingly.

This result resonates with previous gamification research. A successful design usually explicitly reinforces performance expectations, such as using points to award students with corrected answers in the class (Çakıroğlu et al., 2017). For example, the gamified discussion forum developed by Ding and her colleagues (2017, 2018, 2019) used badges to lay out the specific learning behaviors that were expected in the online discussion forum. Yildirim and colleagues (2016) informed students of the meaning of each badge and how to win them in their gamification research. The interviews in their study showed that the badges encouraged students to be proactive in their learning. Identifying the course performance expectations and then aligning the gamification elements with them can lead students to put more effort in the learning activities and receive competence satisfaction by winning the awards.

Awarding Challenging Tasks Leading to Active Participation. In this gamification design, the facilitator bonus valued 10 times as posting a message and about three times as initiating a discussion thread, which signaled it as a relatively challenging task in the course. To win the facilitator bonus, the student facilitators should have at least one turn of conversation with each classmate. Given the rule that the number of a facilitator's messages cannot be more than half of a thread, the gamified course facilitators frequently posted the New-info response to solicit non-facilitator's replies to keep the discussion developing.

When the awards were not all directly related to the learning achievements, and when the awards were basic course requirements rather than challenging tasks, the awards failed to present student competence levels regarding learning (e.g., Kyewski & Krämer, 2018; Hanus & Fox, 2015). Additionally, the value of the awards should match the efforts needed in the activity. In Ahn et al.'s (2019) study, the awards depended on task completion instead of a task's difficulty level. The participants in their study used strategies that could win them more points with less effort, which led to disappointing results. The awards in a gamification design should be weighted based on the challenging levels so that winning the awards could present the competence levels accordingly.

THE ISSUES OF THE DELIVERABLES OF THE GAMIFICATION ACTIVITY

The deliverable of a gamification activity plays an important role in a gamification design. The quality badge in this study was designed to encourage students to write peer-recognized meaningful messages, while the class level interaction displayed similar significant response-chains in the two courses. The quality badge was determined by peers through a rating system embedded in the Blackboard. However, only four messages were rated in the six weeks, and all four messages had five stars ratings. Thus, the quality badges were only issued in two weeks to four students. The participation level of the peer evaluation activity was low in the gamified course. Even though the badge informed students the importance of the quality, the low participation rate made the badge fail to fully perform its function. Future gamification design should pay attention to the deliverables of the gamification activity to ensure its participation.

LIMITATIONS

There were several limitations in the current study. First, the sample size was small. This may have limited the generalizability of the study results. For future research, a larger

sample and random assignment could help to eliminate alternative explanations and provide more rigorous evidence for the proposed gamification design. The graduate level course used in the study only lasted six weeks. In the future, the gamification design could be implemented in a longer course to examine whether students could maintain the active participation and quality interaction over a longer term.

Even though the gamification elements selected in this study were designed to fulfill student competency needs, the study did not measure students' needs satisfaction levels. The positive influence of gamification could also be caused by social comparison (Hanus & Fox, 2015) or novelty (Looyestyn et al., 2017). Additionally, the study compared student interaction using commenting behavior and response types, so it was unclear whether the interaction differences found in the study led to any learning gain differences between the two groups. Several empirical studies showed that high levels of student engagement in the gamification course resulted in better learning outcomes (e.g., Hsu & Wang, 2018; Tsay et al., 2018; Çakıroğlu et al., 2017). Further research is needed to investigate student needs satisfaction and learning gains in order to explain the mechanism of the gamification design's effect.

CONCLUSIONS

This study elaborated on a case of using a gamification design to improve interaction among students in online discussion forums. The gamification elements were designed based two principles according to PENS to satisfy student competency needs and thus maintain their activity levels to work towards a knowledge building online discussion. The findings showed in the gamified course, student interaction in the online discussion forums presented a more decentralized pattern and the student facilitators were more active while it also revealed design issues with the deliverables of the gamification activities. Based on the results, we proposed that the awards in a gamification design should be aligned with the course performance expectations and the awards should be weighted based on the challenging levels of the learning tasks. Additionally, the determination of the according performance expectations and the challenging levels of the learning tasks is dependent on the accumulated research on the subject area. Thus, receiving the award could bring students the experiences of mastery in the course. Finally, it should also be noted the deliverables of the gamification activity should be carefully designed to encourage participation or it would not reach its full potential.

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APPENDIX

Type	Definition	Example
Initial Response (I)	• A statement of observation or opinion	*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.*
Paraphrase Responses (P)	• A statement of agreement from one or more other participants	*I agree with your statement. Money changes a lot of things and can determine different factors.*
New-info Response (N)	• Corroborating examples provided by one or more participants • Asking and answering questions to clarify details of statements • Definition, description, or identification of a problem	*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 some cases 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.*
Building-on Response (B)	• The discovery and exploration of dissonance or inconsistency among ideas, concepts, or statements • Negotiation of meaning/construction of knowledge • Testing and modification of proposed synthesis or co-construction • Agreement statement(s)/applications of newly constructed meaning	*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?*
Non-Academic Response (NA)	• Appreciation and off-task conversation	*Very creative and a blast from the past before emojis, high definition and even color printers.*

Adapted from Gunawardena, et al. (1997) and Hew and Cheung (2011)