

Gamification of online learning

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Abstract. The gamification of online learning has been a subject of interest lately. This study attempts to explore two things in particular, the effects of gamification on learning and the moderating effects of user characteristics. The results demonstrate that the gamification elements contribute to higher learning outcomes while two user characteristics, agreeableness and pre-training motivation, are important moderators of the links between the gamification elements and learning outcomes. The study findings indicate that a gamified system in consideration of user characteristics is an effective means to improving the efficacy of the e-learning environment.

Keywords: gamification, engagement, personalized learning

1 Introduction

Online education has become widely available and popular as more providers, such as leading universities, are launching online courses and educational services. However, it is still a big challenge to maintain the learner's motivation high even when the quality of online education is high. One possible solution is 'gamification,' which refers to 'the use of game design elements in non-game contexts' [2,4]. Gamification can be used to motivate and elevate the user's engagement with systems. Social media platforms (e.g. Four-square) and many mobile applications (e.g., Nike+) implement gamification for raising and maintaining motivation of the user.

In this study, we designed a gamified e-learning environment to evaluate and observe the effects of gamification on student learning. Some recent studies [3] have shown the potential of using gaming elements for enhancing learning outcomes, but there is little attention on evaluating various dimensions of the user's reactions to gamification elements. The various dimensions can contribute to the understanding of users and ultimately help design a personalized gamification environment where gamification elements can be carefully controlled to fit the users' characteristics. Toward this goal, this study uses a mix of traditional game elements and time pressure in order to create a gamified environment. Gamification elements are carefully chosen from a list of game elements [4] while time pressure is chosen and treated separately because of its popularity in game environments and potential strength in altering human behavior [1]. The evaluation of the learning out-

comes and user reactions from utilizing the proposed game environment should provide solid grounds to observe and understand the effects and user reactions to gamification elements and their interaction with users' personal characteristics.

2 Test System Design

Our gamified system was designed to learn how to use the software Adobe Photoshop. The popularity of Photoshop made it a highly desirable skillset and the difficulty level was suited for university students. The developed system was envisioned to educate students to learn the image editing tools and procedures in Photoshop while providing important insights into student accomplishments and insights.

The system consisted of multiple sessions, each of which was focused on learning one specific tool. Each session in turn consisted of a series of segments. Each segment was divided into two components: a tutorial and a quiz. The tutorial component provided learning material and the quiz component tested the user on that learning material provided in the tutorial. Game elements applied to this system included: experience points and levels, a growing avatar that changed its form according to the level of the user, point system that accumulated points for correctly answering quizzes, hearts that provided challenge to learning materials by expelling the user from the session if they exceeded an incorrect limit for the quiz in a session, and finally time pressure on the quizzes to challenge the user as well.

3 Experiment

3.1 Participants

114 volunteers (74 male and 40 female) served as the experimental participants. They were either undergraduate or graduate students, who voluntarily participated in the experiment. The ages of participants ranged from 17 to 30, with the mean age of 21.13. Pre and post experiment comprehension was measured through a set of test that evaluated the learning achieved through the experiment. Also a pre-test survey of user characteristics including big five personality traits, pre-training motivation, Photoshop experience and demographic factors, was conducted while post-test survey for user engagement, Photoshop self-efficacy, and satisfaction were collected.

3.2 Experimental Settings

To examine the effects of proposed gamification in online education, we set two different training conditions with one control group.

Control group. The aim of control group was to compare the performance of this group

to treatment groups. The system did not include any of the game elements used. The participants in this group only had learning contents and quizzes. A simple feedback regarding the correctness of the answer was provided during a quiz.

Gamification group. The system was added with game elements, levels, point, life points, avatars and imaged feedbacks. Solving quizzes in the learning session affected the user’s level, point, and growth of avatar. There were three ‘hearts’ in each session that represented the number of chances to solve the quizzes. If the participants lost all of ‘hearts’, they would have to try the session again. If the answer was right, points were given. If the answer was wrong, a ‘heart’ was erased.

Gamification with time pressure (GTP) group. In this treatment, a time limitation was added to the quiz session. The remaining time was displayed on the screen and alerts, the screen flashing red, were given for the last 5 seconds. If the answer were not given within the time limitation, it was considered an incorrect attempt.

4 Results

Table 1. Descriptive Statistics and results of ANOVA (* $p < .05$, *** $p < .001$)

Group	N	Post-Comp	AvgTime	CompleteQuiz
Control	41	11.85 (2.14)	9.19 (1.52)	75.61 (10.03)
Gamification	40	13.03 (1.87)	8.76 (1.98)	94.58 (15.59)
GTP	33	12.91 (1.79)	7.46 (0.85)	98.67 (17.60)
F score		4.35*	11.90***	27.68***

The descriptive statistics and analysis of variance (ANOVA) results of the experiment are shown in Table 1. The post comprehension test ($F = 4.35$, $p < .05$), average time taken for each quiz ($F = 11.90$, $p < .001$), the number of completed quiz ($F = 27.68$, $p < .001$) showed significant differences between the three treatment groups. Specifically, the gamification group demonstrated the highest score in post-comprehension, and the control group achieved the lowest score. Both environments with gamification produced higher learning outcomes relative to the control group. Interestingly, the time pressure group produced a higher level of comprehension than the control group while using much less time. Fisher’s least significant difference (LSD) test revealed that the two treatment groups performed significantly better for post comprehension test and number of completed quiz than the control group. Likewise, the LSD test on average time showed that users in the time pressure group used significantly shorter time than the other groups.

Among the many user characteristics, two dimensions demonstrated strong influence to the post-comprehension of users. As shown in Table 2, analysis of covariance (ANCOVA) shows that agreeableness and pre-training motivation serve as important moderators of the gamification effects on post-comprehension. Users with low

agreeableness (the ability to relate to a system) in the non-gamification conditions show lower learning while users with low agreeableness in the gamification conditions show higher learning, indicating that the gamification conditions were more conducive to learning for users with low agreeableness. It seems that those gamification elements effectively attracted those users with low agreeableness and those elements improved their comprehension of the material, relative to those similar low agreeableness users in the non-gamification condition. The results also show that time pressure heavily affects users with high motivation, but its effect is not so potent for users with low motivation ($F=3.53$, $p=0.06$). These study results provide useful insights for designing future systems with gamified elements tailored for different individuals.

Table 2. Descriptive statistics between gamification, time pressure and user characteristics

Treatment	Agreeableness	Post-comp (N)	Treatment	Motivation	Post-comp (N)
No gamification	High	12.20 (20)	No time pressure	High	12.26 (43)
	Low	11.52 (21)		Low	12.63 (38)
Gamification	High	12.48 (33)	Time pressure	High	13.38 (16)
	Low	13.38 (40)		Low	12.47 (17)

5 Conclusion

The observed results from the study show that the game elements, such as points, levels, avatars, and time pressure can improve the overall effectiveness of an online learning system. The results also show that depending on the user characteristics, different game elements can alter learning outcomes. We believe that such discovery is a positive step towards providing an online learning system that enhances learners' motivation with personalized game features. A future study should attempt to evaluate more detailed relationships between individual game elements and personal characteristics.

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