Effects of Gamified Quiz to Student's Motivation and Score

Yuki Tanaka*, Hidetake Uwano†, Tomohiro Ichinose‡, Shinya Takehara§
*Dept. Information Engineering
National Institute of Technology, Nara College, Nara, Japan 639–1080
Email: tanaka@info.nara-k.ac.jp
†Dept. Information Engineering
National Institute of Technology, Nara College, Nara, Japan 639–1080
Email: uwano@info.nara-k.ac.jp
‡Graduate School of Information Science
Nara Institute of Science and Technology, Nara, Japan 630–0192
Email: ichinose.tomohiro.ik1@is.naist.jp
§Dept. Liberal Studies
National Institute of Technology, Nara College, Nara, Japan 639–1080
Email: takehara@libe.nara-k.ac.jp

***Abstract*—In this paper, we analyze an effect of gamification to student's motivation and quiz score in practical lecture scene. We use e-Learning system with ranking module to motivate students toward a quiz preparation. As a result of the experiments, 44% students answered that their motivation toward the quiz preparation was increased. We also found that the student's competitive-mind affected how the ranking system effected their motivation and score.**

I. Introduction

High motivation of students toward class and study is essential for active learning in education [1]. Lack of motivation might cause the passive participation, lower score, insufficient preparation, and frequent absence or lateness. On the other hand, motivated students participate in the class actively with sufficient preparation: as a result, the higher score comes out.

Gamification is one of the way to increase motivation of workers, system users, students, and other people [2], [3]. Gamification is to apply a game concept to non-gaming contents. Many studies evaluated the effectiveness of applying gamification to simple work [4], [5] and education [6], [7], [8], [9], [10]. Barata et. al explored how gamification can be applied to education in order to improve student engagement [6]. They added a few game elements toward lectures, such as XP, progress levels, a leaderboard, challenges, and badges. The results showed that students participate more actively in the forums, and pay more attention to the lecture slides.

In this paper, authors evaluate the effectiveness of a gamification element to students' motivation and score. In ordinary educational institutions, students get a new knowledge through lectures. After the series of lectures, teacher evaluates their abilities and knowledge through exam. Students review the contents of lecture before the exam to fixate (or to understand) their knowledge. Here, we hypothesize that motivating students toward exam preparation increases the efficiency of knowledge acquisition. In the experiment, the students who take a lecture are divided into two groups, gamified and non-gamified. We inform gamified group that gamified-quiz is performed afterwards; then compare the quiz score and motivation toward a quiz preparation between two groups. As the gamification element, we use ranking (so called leaderboard,) which is well used element in gamification [6], [8] and suitable for quantitative metrics such as score and grade. Cheong et. al estimated students' subjective evaluation for the quiz with ranking based on quiz score through the questionnaire [8]. In this paper, we analyze the subjective evaluation and quiz score to evaluate the effectiveness of the gamification. We also analyze the relationship between individual competitive-mind and effect of the ranking. To evaluate several gamification elements at single experiment is hard to understand the effect of the individual element. Therefore, we focus the particular gamification element to analyze the effect separately.

II. Experiment

A. Setting

In the experiment, we measure the effect of the ranking for 1) the motivation toward preparation and 2) quiz score. We use moodle[1], Web-base open source platform to education as an e-learning system. We installed the system to our server, and then added three plug-in modules, quiz, ranking and questionnaire. Ranking is displayed on the system with each student's ID. Each ID is given from well-known persons in Japanese history for student's privacy.

The lecture of the experiment is "Politics and Economics", a compulsory subject for the third grade students of our school held in 2015. The number of attendee in this lecture is 186; they divided into five classes. The lecture is charge of the same teacher to every classes and a criterion is also same. We defined three classes (104 students) as $Ranking$ group, and

[1]https://moodle.com

Quiz preparation	I am motivated to study harder than usual when informed that ranking is used. [Disagree 1 2 3 4 Agree]
Amount of studies	I changed the amount of study compared with usual after informed that ranking is used. [Increase, Decrease, Not different]
Informed timing	Which timing is better to inform that the quiz with ranking is performed, Just before the quiz or before more than one day from the quiz? [Just before the quiz, before more than one day from the quiz, Do not care]
Continuation	I want to use quizzes with ranking continuously. [Disagree 1 2 3 4 Agree]
Test type	Which do you like better, Web test or paper test? [Web test, Paper test]

Fig. 1. Questionnaire for motivation

the other two classes (82 students) as $Non\text{-}ranking$ group. Both groups are informed that the quiz is performed at two weeks after. In addition, $Ranking$ group is informed that the quiz score is opened to other student with their ID through e-Learning system. The quiz is carried out on moodle quiz module at the beginning of one lecture. The quiz consists of 15 four-choice questions with eight minutes time limit. The content of each question is learned in the lecture until the quiz. The quiz score is the number of correct answer; the range of score is from zero to 15. This score is reflected to final grade of the lecture.

The motivation toward a quiz preparation is measured by a questionnaire after the quiz. Figure. 1 shows the questionnaire used in this experiment. Questions about the motivation toward a quiz preparation, and amount of studies are asked to $Ranking$ group. Questions about the informed timing and continuation are asked to students who have an experience of gamified quiz in past experiment. All students answer each question through moodle questionnaire module. The questionnaire also includes the fields to write comments about each questions. In this paper, we describe the results about the quiz preparation only.

Flow of the experiment is shown below.

1) Inform $Ranking$ group about the quiz with ranking two weeks before the quiz. Also inform $Non\text{-}ranking$ group about the ordinary quiz.
2) Both groups take the quiz on moodle.
3) Ranking of the quiz is displayed for $Ranking$ group.
4) Both groups answer the questionnaire.

B. Achievement Motivation

To analyze a relationship between individual competitive-mind and the effect of ranking, "The scale of achievement motivation" [11] is used. This metric measures the achievement motivation such as "I want to achieve the things completely"

1. I want to do things better than others.
2. I am happy when I win the competition.
3. I am upset when I lose to competitor.
4. I want to excel than others by all means.
5. We work and study in order to not losing to others.
6. In present society, strong people promote and win.
7. I want to choose the company assessed high rating.
8. Success means obtaining the honor and status.
9. Aiming to high status of society is important.
10. I wish I want to succeed in the world.

Fig. 2. Questionnaire for competitive-mind

and "I want to try the difficult things, and to be successful." This questionnaire consists of 23 questions and we selected 10 questions related to competitive-mind. Figure. 2 shows the questionnaire that we use in the experiment. Original question is written in Japanese; we use without any change. Each question has seven Likert scale; from seven (Strongly agree) to one (Strongly disagree.)

Individual competitive-mind is evaluated from the total number of ten answers of the questions: the range of the competitive-mind is from 10 to 70. The higher number means the higher competitive-mind. This scale is validated by the other research [12], and described that the average score of common university students is 46.3.

Students in $Ranking$ group answer the questionnaire after the questionnaire for motivation described in II-A. They answer the questions through moodle questionnaire module. In this paper, we analyze the relationship among the competitive-mind, motivation and quiz score of students.

III. Result and Discussion

A. Motivation

Table. I shows the results of the questionnaire; motivation of the quiz preparation. The question is answered by 104 students. The second column of the table shows a each ratio

TABLE I
MOTIVATION FOR QUIZ PREPARATION

Motivation	All	2nd time	1st time
1 (low)	28%	18%	32%
2	28%	33%	25%
3	17%	18%	17%
4 (high)	27%	30%	25%

of all students' motivation. Some of the students have an experience of the quiz with ranking in past experiment. The third column of the table shows motivation of students who have a past experience of the quiz with ranking, and fourth column shows motivation of students who have no experience of the quiz with ranking. The result shows that 44% students answered 3 or 4 (high motivation), and 56% students answered 1 or 2 (low motivation) in total; more than half of students' motivation was not increased. A comparison of the first time students and second time students shows that the second time students are more motivated than the first time students. We think the reason why the first time students have a lower motivation is that they cannot imagine what the quiz with ranking is. In contrast, the second time students know about the ranking; hence, students who prefer the gamification is motivated by the ranking than the first time students.

Free comment in questionnaire shows many students write about competitive-mind such as "My motivation increased because I didn't want to lose against others." and "My motivation didn't increase because I didn't care the ranking.". These comments suggest that competitive-mind of each students influences the effectiveness of ranking to their motivation. To show the quiz score for other students includes a competitive element. Therefore, student's competitive-mind affects that the ranking is effective or not. Students also commented "I didn't think I tried to do my best because this is just the one of the quizzes." In this lecture, proportion of the quiz for entire lecture grade is a little.

B. Quiz Score

Figure. 3 shows the quiz score of $Ranking$ group and $Non\text{-}ranking$ group. Each score of groups are normalized by each student's mid-term grade (expressed zero to 100) and average grade of all students at mid-term. The normalized students' quiz score S_n is calculated from following formula:

$$S_n = \frac{S}{\frac{G_m}{G_{ave}}} \tag{1}$$

In this formula, S is a score of a student, G_m is a student's grade at mid-term, and G_{ave} means average grade of every student. As the result, the average value of $Ranking$ is slightly lower (0.5) than $Non\text{-}ranking$; there is no significant difference between them. More than 20 students comment in their questionnaire such as "I forgot about the quiz." therefore, students in $Ranking$ group might did not prepare for the quiz.

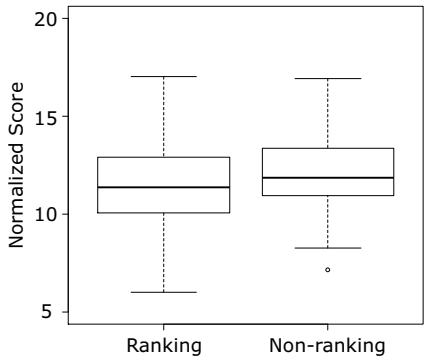

Fig. 3. Normalized score of two groups

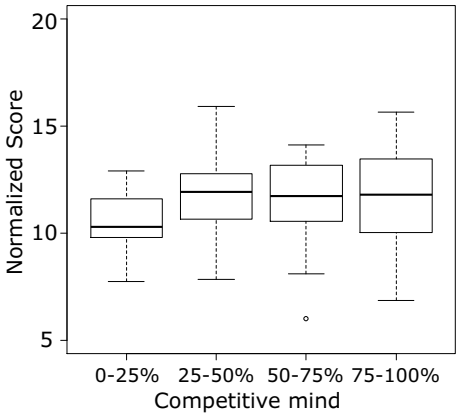

Fig. 4. Normalized score of each achievement motivation group

C. Achievement Motivation

We divided students into four groups based on the value of achievement motivation for detailed analysis. Table. II shows the average values of each group's motivation for quiz preparation. Also the table includes the result of Wilcoxon rank-sum test between two groups of different achievement motivation. The table shows that the lowest group of the achievement motivation (0%–25%) has the lowest motivation for quiz preparation. On the other hand, the highest group of the achievement motivation (75%–100%) has the highest motivation for quiz preparation. Two groups (25%–50% and 75%–100%) have significant difference between 0%–25% group. The result suggests that students are motivated by the ranking, except students who have a low achievement motivation.

Table. III shows the average values of each group's quiz score and p-value (t-test.) Figure. 4 shows box plot of the each group's normalized score. The table shows a similar tendency to the motivation for quiz preparation: the lowest group of the achievement motivation (0%–25%) has the lowest

TABLE II
P–VALUE FOR MOTIVATION FOR QUIZ PREPARATION OF EACH ACHIEVEMENT MOTIVATION GROUP

Achievement motivation	Quiz preparation	p-Value			
		0%–25%	25%–50%	50%–75%	75%–100%
0%–25%	1.92	-	0.0337	0.1558	0.0497
25%–50%	2.58	0.0337	-	0.7031	0.8279
50%–75%	2.42	0.1558	0.7031	-	0.5512
75%–100%	2.63	0.0497	0.8279	0.5512	-

TABLE III
P–VALUE FOR NORMALIZED SCORE OF EACH ACHIEVEMENT MOTIVATION GROUP

Achievement motivation	Normalized score	p-Value			
		0%–25%	25%–50%	50%–75%	75%–100%
0%–25%	10.6	-	0.0230	0.0685	0.0679
25%–50%	11.7	0.0230	-	0.7319	0.8938
50%–75%	11.5	0.0685	0.7319	-	0.8611
75%–100%	11.6	0.0689	0.8938	0.8611	-

score. Also the significant difference is observed between 0%–25% and 25%–50% ($p < 0.05$.) The highest group of the achievement motivation (75%–100%) has better score than 0%–25% group, however there is no significant difference ($p < 0.05$.) Correlation coefficient between the achievement motivation and normalized score is 0.1323 with no significant differences ($p = 0.2037$.)

These results suggest that students with very low competitive-mind receive a only a little effect from ranking, or even receive a bad effect. The effect of the students' competitive-mind to their motivation and quiz score with ranking is one of the interesting research topics.

IV. CONCLUSION

In this paper, we performed the quiz with ranking, one of the gamification elements on e-Learning system and analyzed its effects to students' motivation and score. As the result of the experiment, 44% students answer the questionnaire that their motivation toward the preparation of the quiz was increased. There is no significant difference between the quiz score of $Ranking$ and $Non\text{-}ranking$. Analysis of relation between competitive-mind and motivation for quiz preparation shows that lower competitive-mind students tend to low motivation and score. The result suggests that when we introduce the ranking system into education, consideration for student's competitive-mind and personality is essential.

In our experiment, some students commented about user ID such as "I want to get the high score like being worthy of user ID." We selected name of famous historical person as a student ID. When the ranking is displayed to student, they talk about the name and their rank, especially about two clan masters who fought in historical battle. User ID is treated like the real name on e-Learning system. Therefore, appropriate user ID for educational system is worth to consider.

As a future work, we need to consider the students with low competitive-mind. Introduction of another gamification which has no relation with competition is one of the solutions for the low competitive-mind students. Achievement element (get an imaginary trophy or title based on the result) is one of the examples. We also need to improve a measurement method of the student's motivation by a set of more reliable questionnaire questions. An experiment in a long term class including gamification is one of the important research topic to evaluate the effectiveness of the gamification.

REFERENCES

[1] A. Krapp, "Interest, motivation and learning: An educational-psychological perspective," *European Journal of Psychology of Education*, vol. 14, no. 1, pp. 23–40.

[2] S. Deterding, M. Sicart, L. Nacke, K. O'Hara, and D. Dixon, "Gamification. using game-design elements in non-gaming contexts," in *CHI '11 Extended Abstracts on Human Factors in Computing Systems*, ser. CHI EA '11. New York, NY, USA: ACM, 2011, pp. 2425–2428.

[3] S. Deterding, "Gamification: Designing for motivation," *interactions*, vol. 19, no. 4, pp. 14–17, Jul. 2012.

[4] W. Li, T. Grossman, and G. Fitzmaurice, "Gamicad: A gamified tutorial system for first time autocad users," in *Proceedings of the 25th Annual ACM Symposium on User Interface Software and Technology*, ser. UIST '12. New York, NY, USA: ACM, 2012, pp. 103–112.

[5] Z. Fitz-Walter, D. W. Tjondronegoro, and P. Wyeth, "Orientation passport : using gamification to engage university students," in *OzCHI 2011*. Australian National University, Canberra, ACT: ACM, November 2011.

[6] G. Barata, S. Gama, J. Jorge, and D. Gonçalves, "Improving participation and learning with gamification," in *Proceedings of the First International Conference on Gameful Design, Research, and Applications*, ser. Gamification '13. New York, NY, USA: ACM, 2013, pp. 10–17.

[7] G. Barata, S. Gama, J. Jorge, and D. Goncalves, "Engaging engineering students with gamification," in *Games and Virtual Worlds for Serious Applications (VS-GAMES), 2013 5th International Conference on*, Sept 2013, pp. 1–8.

[8] F. Cheong, Christopher; Cheong and J. Filippou, "Quick quiz: A gamified approach for enhancing learning," in *PACIS 2013 Proceedings*, ser. Paper 206, 2013.

[9] P. Liu and Z. Peng, "Gamification interaction design of online education," in *Instrumentation and Measurement, Sensor Network and Automation (IMSNA), 2013 2nd International Symposium on*, Dec 2013, pp. 95–101.

[10] A. Bartel, P. Figas, and G. Hagel, "Towards a competency-based education with gamification design elements," in *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, ser. CHI PLAY '15. New York, NY, USA: ACM, 2015, pp. 457–462.

[11] H. Hori and F. Yoshida, *Scales of Psychometric Method II (in Japanese)*. Science-sha Co., Ltd., 2008.

[12] M. HORINO and K. MORI, "The effects of achievement motivation on relationships between depression and social support," *The Japanese Journal of Educational Psychology*, vol. 39, no. 3, pp. 308–315, 1991.