Improving Students' Performace Through Gamification: A User Study

Natalia Nehring, Nilufar Baghaei and Simon Dacey
Department of Computer Science, Unitec Institute of Technology, Private Bag 92025, Auckland 1142, New Zealand

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Abstract: Lack of motivation is an issue for some learners. If they do not find the course materials engaging, they do not spend enough time to gain a deeper understanding of the subject matter. The term gamification is used to denote the application of game mechanisms in non-gaming environments with the objective of enhancing the process. Gamification has been shown to be an effective and motivating technique for enhancing students' learning outcome. In this paper, we evaluate the effectiveness of a web-based gamified tool (PeerWise) in enhancing tertiary students' performance doing a Computer Science degree at Unitec Institute of Technology. PeerWise allows students to actively participate in a subject by authoring their own questions and answering, commenting on and rating other students' questions. Results of an evaluation study conducted over 11 weeks (n = 180) showed that using the tool (both voluntary and compulsory) improved students' performance and they found it valuable for their learning.

1 INTRODUCTION

The term gamification is used to denote the application of game mechanisms in non-gaming environments with the objective of enhancing the process enacted (Deterding et al., 2011a and Nacke, 2011). Gamification is related to pre-existing concepts such as serious games, playful interaction and game-based technologies (Deterding et al., 2011b O'Hara, and Dixon, 2011). Gamification, in an educational context, can be applied at elementary education, lifelong education, and higher education levels.

Some learners drop out of study and/or achieve poor results due to lack of motivation (Fan and Wolters, 2014) and the low engagement with the content (Yang, 2013). Gamification has been shown to increase learners' engagement with course materials and improve their motivation, learning participation and collaboration (Angelova, 2015; Dicheva et al., 2015). Gamification has potential, but a lot of effort is required in the design and implementation of the experience for it to be fully motivating for participants (Domínguez et al., 2013).

PeerWise, https://peerwise.cs.auckland.ac.nz/, (Denny et al., 2008b 2008a, 2008b) is a freely available gamified badge-base achievement tool. It allows students to author multiple-choice questions based on their understanding of the subject, and answer, comment on and rate other students' questions, thus supporting active learning (Bonwell, 1991), curiosity, creativity, problem solving and collaboration. Students get more points and badges by creating and explaining their understanding of course related assessment questions, and by answering and discussing questions created by their peers. PeerWise provides students with a *reputation score*, which is an approximate measure of the value of student's contributions to others and it gradually increases over time. The individual components of the one's score are based on the questions they have posted, their answers to questions and their evaluations. A user's reputation score will only increase when other students agree with, or endorse his/her contributions. PeerWise has been reported to stimulate a profound learning and to improve students' performance (Denny et al., 2008a and Luxton-Reilly, 2010; Danny, 2015).

In this paper, we investigate the effect of compulsory vs voluntary use of a web-based gamified tool on students' learning outcome in a computer science course. The research questions we are investigating are: 1) Will using a gamified tool in a CS course improve the learning outcome of our students? 2) Is there any correlation between using

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PeerWise throughout the semester and the course formal assessments' results? 3) Is there any difference in learning outcome, if course marks are allocated to PeerWise contribution? 4) What is the students' perception of having a gamified tool embedded in their study? The rest of the paper is organised as follows. Section 2 gives an overview of recent literature. Section 3 presents the methodology and Section 4 reports our initial findings. Section 5 concludes the paper and highlights future research opportunities.

2 LITERATURE REVIEW

Currently students are digital natives and they have a different profile. They grew up with digital technologies and have different learning styles, new attitude to the learning process and higher requirements for teaching and learning (Kiryakova et al., 2014).

Some reviews of the literature available have already been carried out: Gamification in education: A Systematic Mapping Study (Dicheva et al., 2015 and Angelova, 2015), A systematic mapping on gamification applied to education (de Sousa Borges et al., 2014 and Isotani, 2014) and Gamification and education (Caponetto et al., 2014 2014). Research objectives in gamification articles can be categorised into behavioural change, challenging the students, engagement, improving learning, mastering skills, producing guidelines and encouraging socialisation (de Sousa Borges et al., 2014).

Gamification, in an educational context, can be applied at elementary education, lifelong education, and higher education levels. In a practitioner's guide to gamification of education (Huang and Soman, 2013) outline a five step process 1) understanding the target audience and the context, 2) defining the learning objectives, 3) studying the experience, 4) identifying the resources, and 5) applying gamification elements. When considering gamification some key criteria to be considered are the duration of the learning program, the location of the learning (for example: classroom, home, or office), the nature of the learning programme (for example one-on-one or group), and size of class (or size of groups) (Huang and Soman, 2013).

It is also important to define what the lecturer wants the student to accomplish by completing the learning program. Specific learning goals can include the students understanding a concept, being able to perform a specific task, or being able to complete the learning programme (Huang and Soman, 2013). Olsson et al. (2015) pointed that in virtual learning environment users usually feel lonely and puzzled in their learning journey, therefore visualization and gamification may be applied as solutions, but the former worked better than the latter. It is suggested that the effects of gamification are worth studying more deeply and widely on various learning styles. Urh et al. (2015) analysed the use of gamification in e-Learning process, including its advantages and disadvantages, and argued that there were possibilities of practice gamification in higher education. They stated that the application of gamification was designed to meet project objectives, thus different types of education would affect the system development as well as different learning styles and personalities of learners. De-Marcos et al. (2014) conducted a test on the effects of using both social networking and gamification into an undergraduate e-Learning course. The results show that they work well for practical learning but not for gaining knowledge. Although learners' attitude towards study has been improved, their participation and achievement are still low, which is not in line with the assumption that gamification will boost the learning effects. The reasons lying under are worth investigating.

Swacha and Baszuro (2013) proposed an open-source e-Learning platform for computer programming education with gamification concepts and methods. The system takes into account both personal engagement and team collaboration, however, its operability and effectiveness are still to be tested in a real learning environment. Bitonto et al. (2014) presented UBICARE system integrated with gamification mechanism for training and learning purposes, playing the role of improving engagement and interaction. The long-term effects require ongoing research. Osipov et al. (2015), after investigating the effects of gamification, find out that the people with shy personalities don't benefit much since they don't like to collaborate with others. Gene et al. (2014) describe a gamification framework integrated with Massive Online Open Course (MOOC), the purpose of which was to decrease learners' drop-off rate through motivation and collaboration inspiration. The competition from ranking rating, team work from voluntary activity, and the social networking from publishing the number of "Likes" together with course progress and certification gamification elements towards the higher achievement rate of MOOC course. It has proved to be able to play a very good role in promoting learners' motivation and cooperation; however, they pointed out the real effects of

gamification on the quality of learning should be investigated through comparing it with traditional learning process.

One difference between game-based learning (GBL) and gamification is that in GBL learners are playing to learn while gamification is to incentivize learners to learn, which makes game-based learning appear more interesting and engaging (Baghaei et al., 2016; Plass et al., 2015). An analysis of game-based learning and gamification applications in university environment (Cózar-Gutiérrez and Sáez-López, 2016) describes that game-based learning is perceived to improve learners' engagements and active participation while gamification works better for interaction and collaboration. In our earlier work, we investigated whether introducing weekly quizzes improved final mark for the students (Nehring et al., 2017). In this study, we are investigating another type of active learning components, i.e. students participating in writing questions on weekly topic by using a gamified web tool and the effect on enhancing their learning.

3 METHOD

An evaluation study was conducted over 11 weeks period with 180 tertiary students aged 19-29 at Unitec Institute of Technology. The participants were studying a second-year course on Web Design and Development. They were randomly allocated to three groups. The control group (n = 64) did not have access to PeerWise. First experimental group (n = 55) had voluntary participation (*VP*) and second experimental group (n = 61) had compulsory participation (*CP*), meaning 2.5% of total grade had been allocated to their PeerWise contribution.

Figure 1: PeerWise statistics on our experimental groups: voluntary participation (VP) at the top and compulsory participation with (2.5%) mark allocated (CP).

The PeerWise dashboard for our course is shown in Figure 1. It contains information about number of participants, number of questions created, number of answers, number of comments and a date of last answer. PeerWise activity was introduced in week one. Each student was asked to contribute minimum of one question per week.

A subjective evaluation was also conducted to find out what students think about PeerWise. Questions about the user experience were developed and are listed below:

1. Do you believe that participation in PeerWise affect your study habits?
2. Did the participation in PeerWise affect your understanding of how much you knew or how much you had learned about the IWD course?
3. Did you find it stressful to do the PeerWise question(s)?
4. Were your study habits affected by the existence of the PeerWise or your results on them?
5. Do you consider the PeerWise score is a way to encourage better study?
6. Do you think that the spending time on PeerWise was an efficient use of your time?

4 RESULTS

In voluntary participation group (*VP)* 37 students out 55 decided to participate. As shown in Figure 1, The VP group created 96 questions compared with 199 questions created by the CP group. The CP group submitted 3657 answers compared with 1085 submitted by the VP group and the number of comments was 5 times more compared with the VP group.

Our hypothesis was that there is a correlation between PeerWise contribution and the formal assessment's marks and that it would help predict student's results. The initial results show that there is no correlation and the score on PeerWise activity can only predict results for 50% of students. We believe one reason for this is because the marks allocated to PeerWise activity is small and some students ignore it all together.

The semester is currently in progress and we only obtained results for the first formal assessment and compared the groups, as shown in Table 1. The results for the PeerWise participants' marks show that the average scores are higher than the non-participants' marks. The average mark on first formal assessment is 72.2 for the control group, compared with 77.8 for the *VP* group and 78.5 for the *CP* group.

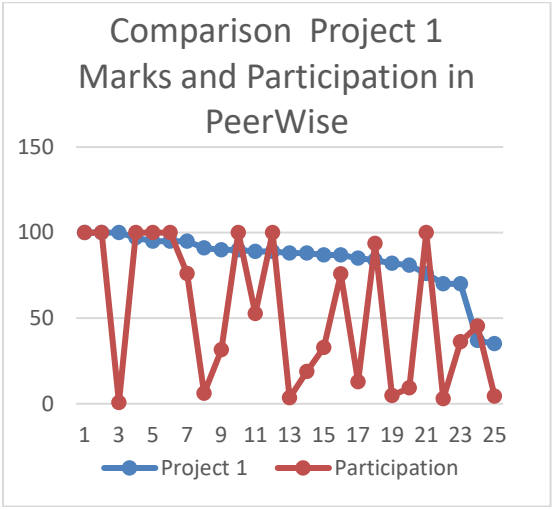

Figure 2: Correlation between PeerWise score and formal assessment marks.

We also looked at the course assessment marks for students actively contributing to PeerWise and students not participating. Their mark is 84.4 in average for the first formal assessment compared with 73.7, as shown in Table 1.

Table 1: Average marks on formal assessments for different groups.

Groups	Assessment	All	PeerWise	Not participated
Conrol group without PeerWise access (n=64)	1	**72.2**	N/A	N/A
	2	76.2	N/A	N/A
	3	83.7	N/A	N/A
	Final	73.1	N/A	N/A
Voluntary participation (VP) (n=55) (PW37)	1	**77.8**	**79.8**	**70.7**
	2	82.1	83	74.6
	3	82.9	83	68.9
	Final	76.5	79.3	70.7
Compulsory participation with course mark 2.5% assigned, (n=61) (PW52)	1	**78.5**	**84.4**	**73.7**
	2	N/A	N/A	N/A
	3	N/A	N/A	N/A
	Final	N/A	N/A	N/A

The subjective evaluation survey was done in week 10. 31 participants chose to take part in this exercise. About half of the students believed that participation in PeerWise on a weekly basis improved their study habit (see Figure 3). The average answer is 5.5 out of 10.

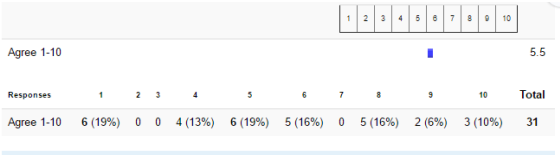

Figure 3. Response to "Do you believe that participation in PeerWise affect your study habit?".

In response to question 1 ("Did the participation in PeerWise affect your understanding of how much you knew or how much you had learned about IWD course"), the results show that 29% said they know less, and 19% found that they know more. (Figure 4).

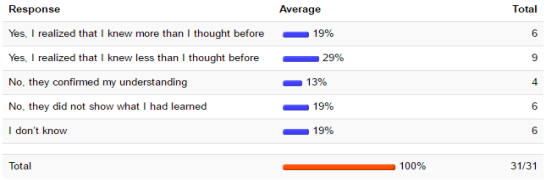

Figure 4: Response to "Did the participation in PeerWise affect your understanding of how much you knew or how much you had learned about IWD course?".

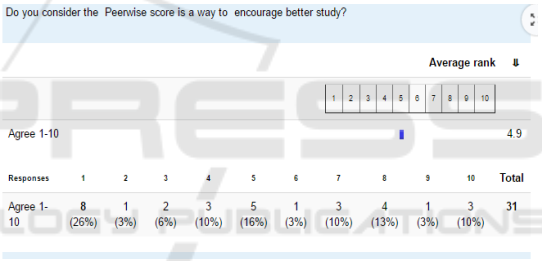

Figure 5: Response to "Do you consider the PeerWise score is a way to encourage to better study?".

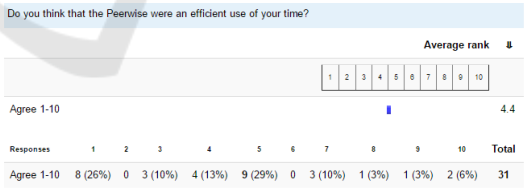

Figure 6: Response to "Do you think that the PeerWise were an efficient use of your time?".

5 CONCLUSION & FUTURE WORK

In this paper, we investigated the effect of compulsory vs voluntary use of a web-based gamified tool on students' learning outcome in a second-year computer science (web design and development) course. We uncovered several interesting observations. The preliminary results show that the

individual reputation scores on PeerWise was not correlated with the average formal assessment results. There was improved performance for both experimental groups (*VP and CP*) who contributed to PeerWise, with more noticeable improvement for the students who actively participated. The *CP* group who had 2.5 course marks allocated to PeerWise contribution authored, commented on and responded to significantly more questions than the *VP* group and did slightly better in the formal assessment. Subjective evaluation showed that half of the participants liked contributing to PeerWise and found it valuable for their learning.

More studies are needed to examine the effectiveness of gamification on students' performance and enjoyment throughout the entire semester. We plan to analyse the difficulty level of students' questions and its correlation with students' achievement level. We will look at further analysing the user interaction data logged on PeerWise, which would allow us to gauge the extent to which the gamification process successfully embeds enjoyable experiences and meaningful learning outcomes. Analysis of the interaction data as well as conducting a series of interviews with participants will also allow us to think in terms of what motivates a student to interact with a web-based gamified tool and how that motivation can be sustained over time. We plan to study the effectiveness of different gamification features on long-term behavioural changes, motivation level and increased knowledge of participants and propose a set of design guidelines. We believe our research paves the way for the systematic design and development of full-fledged gamified tools in the context of education.

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