Massive Courses and Small Games: The Effect of Serious Games on Student Retention in MOOCs

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Abstract

Background. Although the motivational capacity of serious games is well supported in theory, few experimental studies have been conducted so far. This study contributes to this knowledge gap by using a serious game to try and increase the currently low student retention in Massive Open Online Courses (MOOCs).

Aim and method. This article aimed to explore the possibilities serious games offer to increase student retention in MOOCs. For this, a serious game was specifically designed to influence factors that have shown to influence student retention in other MOOCs. A randomized post-test only control group experimental design was used, in which the impact of the serious game on student retention was evaluated with data from questionnaires and the edX platform.

Results. None of the identified factors influenced the student retention in this MOOC. Furthermore, the game had a negative impact on the intrinsic motivation of students, but no difference was observed regarding student retention when comparing the game group and control group.

Conclusions. While it was found that the serious game had a negative impact on the intrinsic motivation of students, it appeared that intrinsic motivation did not influence student retention in this MOOC, therewith explaining why no difference in student retention was observed between the control group and game group. This shows that in order to improve student retention in MOOCs with serious games, further research on factors influencing student retention in MOOCs is required first.

Keywords

Serious games, Massive Open Online Courses, student retention, true experimental design, factor analysis

Introduction

Ever since the introduction of the first Massive Online Open Course in 2008, the popularity of MOOCs has been increasing. MOOCs offer free access to university level information and education for a large number of people via an online learning environment. They have been heralded for offering access to high level education for people with limited high education possibilities, and for promoting lifelong learning, realizing the shift towards a more knowledge based society. Currently there are close to 60 million students enrolled in almost 7000 courses offered by more than 700 universities (Dharwal Shah, 2016). Most MOOCs use quizzes, online assignments and examinations to provide interactive educational content (Tan, 2013), interactions with other students are accounted for via discussion fora (Breslow et al., 2013). MOOCs have been criticized by many for their low completion numbers (Saraguro-Bravo, Jara-Roa, & Agila-Palacios, 2016). The literature review by Jordan (2014) showed that the average completion rate of a MOOC is only 6,5%. This high drop-out of students during the course is a well-known characteristic of MOOCs and has even been named "The Funnel of Participation" by Clow (2013, p. 186).

Based on two key-publications of Malone (1981) and Garris, Ahlers and Driskell (2002) it is generally believed that serious games are suitable for educational purposes due to their motivational potential (Sitzmann, 2011). When analyzing the results of several meta-analysis on the impact of simulation, serious, or digital games show that the game-based-instructional methods are indeed preferred over traditional teaching methods regarding learning outcomes (Clark, Tanner-smith, & Killingsworth, 2014; Sitzmann, 2011; Vogel et al., 2006; Wouters, Van Nimwegen, Van Oostendorp, & Van Der Spek, 2013). However, there is no clear consensus on the motivational impact. Sitzmann (2011, p. 513) in particular states that, given that serious games are primarily known for their motivational potential, *"It is ironic that a dearth of research has compared post training motivation for trainees taught with simulation games to a comparison group".* This article aims to contribute to this knowledge gap by sharing the results of our experiment on the motivational impact of serious games when utilized to tackle low student retention suffered by MOOCs worldwide. This article therewith tries to answer the following research question:

To what extent can student retention in MOOCs be improved by incorporating a serious game?

This research question is answered by first analysing recent findings regarding factors influencing student retention in MOOCs. These findings are then used to identify which factors might be influenced by a serious game. To test if these factors can indeed be influenced by a serious game and if the serious game therewith leads to increased student retention in MOOCs, an experiment is conducted. First the MOOC in which this experiment takes place is described, before the serious game design is presented. After the experimental design, sampling and data collection and data preparation are discussed, the results of the experiment are presented. These results are then discussed and used to draw a conclusion regarding the main research question. Finally, the limitations and recommendations for future research are presented.

Factors influencing MOOC student retention

The field of literature surrounding student retention in MOOCs can be split up into studies analysing the registration phase of MOOCs and studies analysing the activity phase of MOOCs. The studies concerning the registration phase investigate why students enrol and what their intentions are. Studies trying to explain the low student retention by analysing the activity phase of MOOCs are typically concerned with what students indicated themselves was a reason to drop out of a course.

When analysing available literature concerning the registration phase of MOOCs, it was found that students in MOOCs have different intentions when enrolling, as it appears that in multiple MOOC studies a large portion of students do not intend to complete the MOOC from the start (Belanger &

Thornton, 2007; Gütl, Rizzardini, Chang, & Morales, 2014; Wilkowski, Deutsch, & Russell, 2014). When analysing further it was found that student enrolled for extrinsic reasons, intrinsic reasons, to interact with other students, because it was convenient, or to experience online learning. These findings are summarized per author in table 1. Intrinsic motivation is defined as pursuing a task for the satisfaction, engagement or interest the task itself might provide, while extrinsic motivation entails pursuing a task for purposes beyond the task, for example, for payment or to earn a credential (Xiong et al., 2015).

Table 1: Structured findings regarding enrolment motivations

	Belanger & Thornton, 2013	**White et al., 2015**	**Hew & Cheung, 2014**	**Xiong et al., 2015**
Intrinsic motivations for enrolling				
For fun or entertainment	x			
MOOCs satisfy interest		x	x	x
Curiosity			x	
Challenge			x	
Extrinsic motivations for enrolling				
Recognition of accomplishment	x		x	x
Professional development	x	x		x
Supplement to credit bearing course			x	x
Other motivations for enrolling				
Interaction with students	x	x		
Convenient for people with limited access	x	x		
To experience online learning	x			

When analysing the available literature concerning the activity phase of MOOCs, it was found that there is a variety of reasons for students to drop out of the course. In a literature study by Khalil and Ebner (2014) of 42 MOOCs, they identified lack of time, lack of motivation, feelings of isolation and lack of interactivity with students and professors, insufficient background and skills, and hidden costs. The lack of interactivity with the professors and students is also mentioned by several other authors (Adamopoulos, 2013; De Freitas, Morgan, & Gibson, 2015; Hone & El Said, 2016), and comply with the findings of Hew (2016) that both types of interaction engages students. Lack of motivation is also recognized by de Freitas (2015), who states that students are unengaged and need to be motivated in order to increase completion rates.

Hew (2016) found after studying three highly rated MOOCs, that there are five factors that engage students in MOOCs: course resources, instruction accessibility/passion, peer interaction, active learning, problem oriented assignments with clear expositions. Course resources indicate that if there are variety of ways students are able to learn, it provides the availability for each student choose their favourite way and therewith engage. Active learning promotes application of new knowledge in any task or activity, instead of passively reading or listening. Problem oriented assignments with clear expositions highlight that assignments should be oriented at solving real-world tasks. Unfortunately, Hew did not investigate the effect of these factors on course completion. Adamopolous (2013) found that the sentiment of students for assignments and course material has positive effects on the completion rate of the course and Gütl (2014) mentions that poor course design was a reason not to complete a MOOC. Hone and al Said (2016) found that MOOC content has a significant effect on the perceived effectiveness of the course, which in turn significantly influences course retention. This all indicates that the student's perceived quality of the MOOC is also an important factor influencing retention rates

Possibilities for serious games

Drawing upon the previous literature, this study suggest that serious games could be used to influence student retention, by influencing the *intrinsic motivation, extrinsic motivation, interactivity* and *perceived MOOC quality.*

Intrinsic motivation of students is an interesting factor for a serious game to influence as the motivational potential of serious games mentioned in the introduction of this article, is based on their intrinsically motivational capabilities (Csikszentmihalyi, 1990; Garris, Ahlers, & Driskell, 2002; Thomas W. Malone, 1981). *Extrinsic motivation* seems to be an important reason for students to enrol in a MOOC and was found to be a predictor for student retention (Xiong et al., 2015). However, too our knowledge, it has not been researched if serious games could be designed to increase extrinsic motivation. Thus, this factor has to be purposefully accounted for in the serious game design. *Interactivity* might be an interesting factor for serious games to influence as it is specifically mentioned by Malone and Lepper (1987) that interaction with other students is an important aspect of establishing an intrinsically motivational learning environment. This shows that games offer the potential to have students interact with other students. Salen and Zimmerman (2004) also specifically describe the possibility for players to interact with other players as one of the strengths and key concepts of serious games. *Perceived MOOC quality* could be influenced by serious game by increasing the diversity of course resources, enable active learning by applying knowledge in the game and could be used to clarify problems with clear expositions. It is believed that by doing this student perceive the quality of the course as higher.

With these four factors is it believed serious games could influence student retention in MOOCs, more specifically, it is proposed that (1) the four factors influence student retention; (2) a serious game could influence these four factors; and (3) the serious game incorporation increases student retention in MOOCs. These three propositions are visualized in Figure 1.

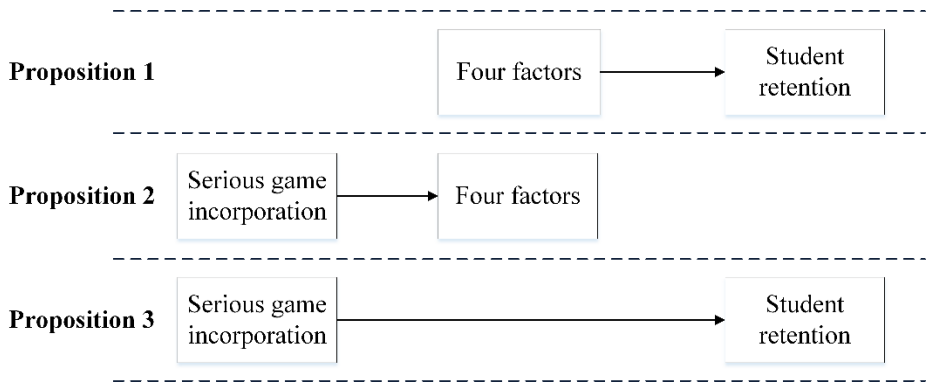

Figure 1. The three propositions showing how serious games could influence student retention in MOOCs

Experiment: The Creative Problem Solving and Decision Making MOOC

The CSPD MOOC is hosted on the edX platform and teaches an analytical approach to solve complex problems. At the start of each course the students choose a case concerning a complex problem, and apply several methods throughout the course to be able to show the owner of the problem what his alternative courses of action are. The MOOC requires no payment to enrol but the students are able to pay before, during, or after completing the course to earn a verified certificate from the TU Delft, This certificate is only issued if the student completes the course with a sufficient grade. The MOOC is self-paced and takes approximately 20 to 40 hours to complete. Before the start of the course the students

are asked to fill in the pre-questionnaire. After that the course starts and the students are guided through 5 similarly structured steps in which one or several methods are taught. Figure 2 shows how a step is structured. At the end of the course there is a small video to wrap up and a post-questionnaire to evaluate the students' experience.

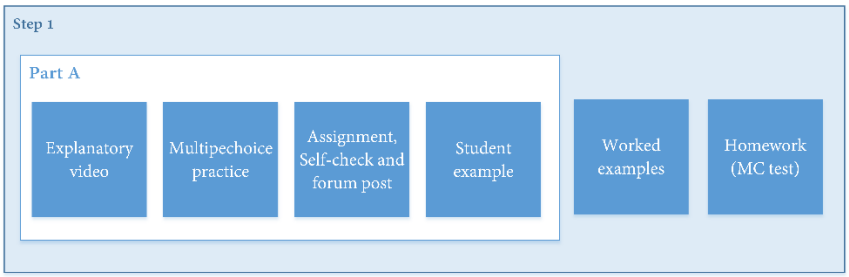

Figure 2. A visualisation of one step in the CPSD MOOC

The Journey Game

The Journey Game design process

The game design process for this study was characterized by the limited time available to design, develop, integrate and test the game. It was therefore chosen to have the game development by InThere, a Dutch company that is specialized in the short-time developing of small serious games (microgames) used to accelerate change and training projects in companies. The InThere game development approach is an adaptation of the Triadic Game Design (TGD) developed by Harteveld (2011), in which the Reality, Meaning and Play aspect of a serious game are the central aspects for design. InThere's adaptation of TGD consists of roughly three phases, the *Gamestorm*, the game design, and the game development. The Gamestorm is the most important aspect of the development approach.

The Gamestorm is a method developed by InThere to greatly reduce design time. The clients are invited to a workshop to intensely discuss the experienced problem over the course of several hours. By providing a structured method, the ambiguity in problem description that is normally experienced when communicating with several people from the client's side through several forms of communication, is reduced. In this case the clients were the MOOC facilitators. Furthermore, a agreement on the problem description serves as a "mental" contract to prevent clients form changing their wishes halfway through the design, which delays the development process. Lastly, the Gamestorm serves as method to make the problem owner feel partly responsible for the game design, ensuring their cooperation and enthusiasm. The focus of the Gamestorm is mostly on the *Reality* and *Meaning* aspect of TGD, but rough ideas for the *Play* (game) aspect are often touched upon. After the Gamestorm, the results regarding the Reality, Meaning and Play are used as input for a preliminary design. This preliminary game design was presented after two weeks to the clients. When the clients agreed to the preliminary design the development phase was initiated.

Game description

The serious game consisted of 1 game per step, each specified to the step's content. Each game consisted of several rounds in which the student had to choose the right answer by clicking on something or dragging something to the right place within a limited timeframe. As example the first game is shown in Figure 3. The time is indicated with the white bar at the top of the screen. At the bottom of the screen the students could see which round they were in and if they answered the previous round correctly (green circle) or incorrectly (red circle).

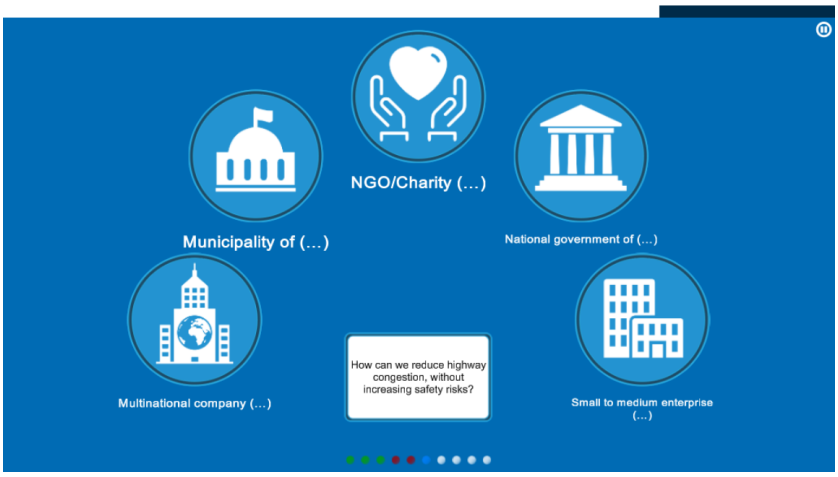

Figure 3. Game 1: Whose problem is it?

At the end of the game the score was computed based on the number of rounds in which a correct answer was given and how much time they had left. Furthermore, students were able to increase their game score with a "multiplier", obtained by answering the multiple choice practice questions in that respective step correctly. The relation between the multiple-choice questions and the games is shown in Figure 4. The student encounters the questions right after the introduction video, just like in the original course. Before they start the questions a message is shown that explains that these practice questions are not of influence on their grade, but they do give the opportunity to earn a multiplier for the game at the end of the step.

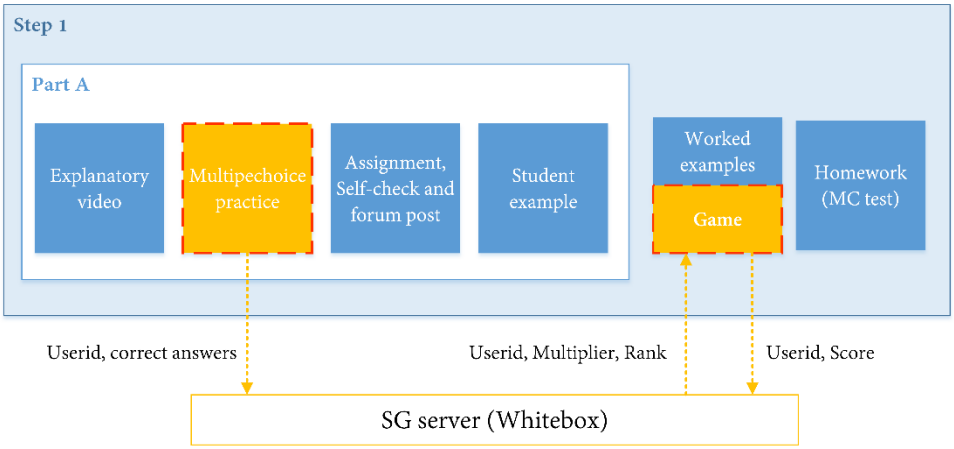

Figure 4. The relation between the multiple-choice questions and the game

When the student arrives at the game at the end of the step, they are first shown an introduction screen. This screen presents text, an illustration of the game and a start button. In the text the students are first welcomed and reminded that they are trying to become a "creative problem solver". This reminder is explicitly made to make students realize why they are following the course, therewith aiming to trigger their *extrinsic* or *intrinsic motivations* for enrolling. As different students have different motivations for enrolling, no explicit motivator is mentioned and the reference is kept vague. The second part of the text briefly explains the game at hand by stating the goal and how this goal is achieved. Lastly, some textual

encouragement is used to make the students realize the game is also "for fun", meaning to trigger their *intrinsic motivators*.

The serious games themselves were designed to be *intrinsically motivating* by representing the course content to make it interesting, and setting a time constraint to make it challenging. Representing the course content was also deemed important to increase the course resource diversity, facilitate active learning and provide problem oriented assignments with clear expositions, which are all four regarded in this study as important aspects to increase students' *perceived MOOC quality*.

When the game is finished, two screens are presented. The first screen gives a quick overview of the score they obtained, the multiplier they earned from the practice multiple-choice questions in this step, and what their final score amounts to. This final score is then compared to other players' highest scores, and the current rank they player holds is presented. This ranking system is important to give students the feeling of competition with other students, therewith possibly improving their *intrinsic motivation* but also their *interactivity* with other students. The student-to-student interactivity and student-to-teacher interactivity is also tried to be influenced by encouraging students to discuss their game experiences on the discussion forum in the MOOC.

Experiment set-up and results

Experimental design

To analyse the effects of the serious game in this game study an experiment is used. The edX platform on which the CSPD MOOC is hosted enables the facilitators to assign students randomly to different cohorts. Furthermore, the content, or treatment, that is accessible by the students can be restricted to one of these cohorts. This enables to randomly assign students to two groups that have access to different content, making it possible to use a randomized post-test only control group experimental design.

Sampling and data collection

Initially this research set out to collect data from all students (N = 6135) present in the MOOC. When analysing the response, it was discovered that 96% out of the initial 6135 students did not finish any assignment in the course. It was decided to count students as *started* students when they finished at least one assignment in the course. This makes it more likely the student intends to complete the course, making the completion rate a more valuable statistic. This meant the sample was reduced to 254 students. All participating students were asked to fill in several questionnaires, which all suffered a high non-response. A pre-questionnaire (N = 97) was used to obtain student demographics and enrolment motivations. A post-questionnaire was used to evaluate the students' score on the identified factors (N = 52). Data on the engagement of the student and if the student completed the course was collected via the edX platform. Lastly, qualitative feedback was collected via the open questions in the post-questionnaire, and via the discussion forum.

Data preparation

As the four identified factors are latent and cannot be directly observed, an exploratory factor analysis was used to create factor scores for each student on each of the four factors. These results were based on directly observable questions (items) in the post-questionnaire. When conducting the factor analysis the items "I felt connected with other students" and "The content's applicability to real-life situations is high", had to be removed to obtain a simple structure. After removing these items it was found that the item "I had fun" had a relatively high factor loading on both intrinsic motivation and interactivity, but as fun still loaded 0.208 higher on intrinsic motivation than interactivity, and there is a strong theoretical basis for "fun" being part of intrinsic motivation, it was decided not to exclude this variable from the

factor analysis. Furthermore, it was found that the item originally intended to measure intrinsic motivation, challenge, is significantly more influenced by perceived MOOC quality than intrinsic motivation. That means students who answered that they continued the course because the felt challenged, saw this as an important quality of a MOOC. As this is not an unthinkable line of reasoning, it was decided to keep this variable as item for perceived MOOC quality instead of for intrinsic motivation. The final measurement model is depicted in Table 2.

Construct	Items	I remained active in the course because… (5-point Likert scale)	Factor loading	Crobach's Alpha
Intrinsic motivation	Im.fun	I had fun	-0.636	0.855
	Im.interest	I found the course interesting	-0.697	
	Im.curious	The course stimulated my curiosity	-0.947	
Extrinsic motivation	Em.certificate	I wanted to earn a certificate	0.723	0.695
	Em.career	I wanted to improve my career	0.618	
	Em.academic	It related to my academic program	0.531	
Interactivity	Int.teach	I felt connected with the teachers	1.013	0.791
	Int.feed	I received enough feedback during the course	0.586	
Perceived MOOC quality	Im.challenge	I felt challenged	0.487	0.787
	Pmq.exercise	There were enough exercises to test my knowledge	1.014	
	Pmq.material	There was enough course material available	0.741	

Table 2. Measurement model for factor analysis

Results

Proposition 1. No significant differences were found for any of the factors scores when students who completed the course were compared with students who did not, using an independent sample t-test (completed N = 39, not completed *N* = 13). The test results are presented in Table 3. No results could be obtained when analysing the correlation between the factor scores and the number of assignments made per student, as it appeared that 93% of the students who filled in the post-questionnaire made all 5 assignments.

Proposition 2. Students in the serious game group reported a *higher* intrinsic motivation factor score than students in the control group (see Table 4). With the factor loading for intrinsic motivation being negative, this meant that students in the game group reported a *lower* intrinsic motivation. No significant differences were found when comparing the factor score means of extrinsic motivation, interactivity and perceived MOOC quality between the two groups.

Proposition 3. No significant difference ($X^2 = 0.110$; df =1; $p < 0.740$) was found between the number of MOOC completers in the control group (42 out of 142, 30%) and in the game group (31 out of 112, 28%). Furthermore, no significant differences ($F = 0.346$; $t = -1.01$; df = 252; $p < 0.424$) were found between the control group and the game group in the total number of assignments made per student. Lastly, no significant difference were found when comparing the average number of forums posts ($F = 0.447$; $t = 0.501$; df = 252; $p < 0.617$). In total there were 323 forum posts, 192 in the control group (N = 41) and 131 in the game group (N = 29), of which only 7 posts were about the game.

Serious game evaluation. The serious game was evaluated with quantitative and qualitative data. The quantitative data consisted of specific questions regarding the *motivational*, *interactivity,* and *perceived MOOC quality* aspects, and if it made students study more to acquire a higher multiplier in the multiple-

choice questions. All questions were answered positively. The amount of qualitative data was limited, which was expected given the quantative focus of this research. It could be derived from the responses that the game was mostly regarded as positive, but the timing of the games needed to be improved as this was a much mentioned negative factor.

Table 3. Results independent sample t-test of factor scores between completers and non-completers

Factor	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Intrinsic motivation	0.874	0.354	0.605	50	0.548	0.181	0.300
Extrinsic motivation	6.018	0.018	-0.419	14.9	0.681	-0.155	0.371
Interactivity	0.683	0.412	0.27	50	0.789	0.086	0.318
Perceived MOOC quality	8.749	0.005	-0.631	14.8	0.537	-0.246	0.389

Table 4. Results independent sample t-test of factor scores between groups

Factor	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Intrinsic motivation	3.441	0.069	-2.102	50	0.041	-0.53147	0.25279
Extrinsic motivation	0.836	0.365	-0.118	50	0.906	-0.03003	0.254044
Interactivity	0.007	0.932	-1.003	50	0.321	-0.27676	0.275869
Perceived MOOC quality	6.190	0.016	1.174	32.9	0.249	0.328818	0.280002

Discussion and Conclusions

The aim of this research was to see to what extent serious games could be used to increase student retention in MOOCs, by designing it to influencing factors that are known to contribute to low student retention. It was proposed that (1) extrinsic motivation, intrinsic motivation, interactivity and perceived MOOC quality influence student retention; (2) a serious game could influence these four factors; and (3) the serious game incorporation increases student retention in MOOCs.

The results show that no significant differences were found between students who completed the MOOC and students who did not, when comparing the four factors scores. Based on these results it can be concluded that the four identified factors do not influence students' course completion, which is not in line with proposition (1). This is a surprising result as previous literature has shown that these were all factors that influence student retention in others MOOCs. However, none of the MOOCs studied in previous literature was self-paced, most studies measured student retention with the engagement of students in the course and not with completion rates only, and there were slight variations in the operationalization of the factors.

The results regarding the impact of the serious game on the four factors showed that the serious game had a negative impact on the intrinsic motivation of students, and no impact on extrinsic motivation, interactivity, and perceived MOOC quality. The negative impact of the serious game on intrinsic motivation was a surprising result, as serious games are theorized to be effective as instructive

environment because of their capability to utilize the intrinsic motivational aspects of games. When analysing the quantitative game evaluation results, the games were regarded as a positive influence on all four factors, including intrinsic motivation. However, when looking at the qualitative evaluation of the game it was found that multiple students indicated that the timing of the games needed to be improved. It is therefore carefully concluded that the lower intrinsic motivation was caused by students disliking the timing in the games. This conclusion highlights the sensitivity of serious games to small design choices, as this small design choice had a large impact on the total game experience.

The effect of the serious game on student retention was assessed by analysing the difference in course completion, assignment engagement and the number of forum posts between the game group and control group. By being able to analyse both student completion and course engagement, both aspects of student retention as defined in this study were present. The results of this analysis show that the serious game incorporation did not affect course completion, the number of assignments made per student, or the number of forum posts per student. Therewith making it possible to conclude that there was no difference in student retention when this serious game was incorporated into this MOOC. The lack of impact of the serious game is not surprising considering the fact that the first proposition did not hold. The game was specifically designed to influence these four factors as these factors were found to influence student retention in related MOOC literature. With no relation between those factors and student course completion, it appears that even if the factors were influenced to great extent by the serious game, no effect regarding course completion would be obtained.

Limitations and recommendations for future research

The low response to the post-questionnaire meant that only 52 responses could be used to conduct a factor analysis, while for a valid factor analysis a minimum of N = 100 is advised. It is believed that a replication of this study with a larger sample could increase the validity to great extent as this would not only increase the data for the factor analysis, but also the serious game evaluation questions. Furthermore, 75% of the students who filled in the post-questionnaire completed the MOOC, indicating a self-selection bias that reduces the extent to which the results can be generalized to this MOOC population.

The external validity of the results to other MOOCs is low as only one MOOC with a tailor made serious game was researched. This means that the findings of this study can only be generalized to MOOCs with similar course design, topic and type of enrolled students. Further work could look into incorporation a similar type of serious game in a different MOOC, to see if the same results are obtained.

The serious game design and development was limited in time and budget, which resulted in some factors being only represented with textual encouragement. It is believed that it is especially interesting to analyse to possibility serious games offer to introduce student-student interaction in MOOCs, as this is a much mentioned factor that influences student retention that is not researched in this study. Furthermore, it was not possible to make the serious game obligatory, as this would also require communication from the serious game to the edX server, which is considerably more difficult in terms of server-side coding. The effect of making the serious game obligatory would be interesting for future research as it could influence the factors and student retention to greater extent.

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