

Personalization of gamification in (programming) e-learning environments

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Abstract. We all advance and learn throughout our lives. First, we learn about ourselves and the world around us through playing games. As we grow up, learning leaves the form of entertainment, and it gradually takes on the outlines of formal education. Formal education, with its strict, pre-defined rules and goals, leaves no room for individual creativity and play. In such a standardized environment, we often find ourselves demotivated and limited, which can lead us to poor learning outcomes or even to giving up on learning. This issue is more often seen in e-learning systems, which, by its nature, require additional educational measures to compensate physical distance, as well as the diversity of individuals who participate in the process of e-learning.

This thesis proposes a model for personalized e-learning environment in which game design principles and game elements are used for the purpose of increasing the participation and engagement of students and, therefore, improving learning outcomes. In order for gamification to be successful different students' learning characteristic are taken into account.

Keywords: Personalized E-Learning, Gamification, Learning characteristics, Engagement, Participation, Instructional Design.

1 Program context

I'm currently positioned as a research assistant at Learning Technologies Research Group, Faculty of Informatics at RWTH Aachen University under the supervision of prof. Dr. Ulrik Schroeder. My three-year studies started in October 2017 and are organized as so-called "individual program" in which researches receive their doctorate by working in research projects and teaching rather than following lectures and doing exams. This research is supported and funded by the world's largest funding organization for the international exchange of students and researchers - German Academic Exchange Service (DAAD) [1].

2 Context and motivation

Issues addressed in this research are presented on the case of RWTH Aachen University, Germany. Namely, the Faculty of Mathematics, Computer Science and Natural Sciences at the mentioned University observed a significant difference between the

number of students who enroll in the programs and that of students which actually get a degree. [2] Dropping out is a general problem at all Science, Technology, Engineering and Mathematics (STEM) university programs, not only in Germany. “Programming courses are compulsory for most engineering degrees, but students’ performance on these courses is often not good as expected...new teaching techniques are required if student are to be motivated and engaged in learning on programming courses”[3]. Many of current studies in field of learning on programming languages [4, 5] showed that there is a evident drop of motivation and engagement among students, especially if the learning is happening in e-learning environments.

In recent years, one of the popular methods of tackling the abovementioned problem is the gamification of the course. Gamification refers to “incorporating game elements in non-game context” [6]. In context of education, it is used as a tool for boosting motivation and engagement among students. Evidence reveals that gamification can be a powerful weapon in instructors’ hand while dealing with poor students’ performance, but its implementation is mainly presented on individual cases and its success differs from study to study [7]. Depending on the environment, participants, learning materials or learning goals gamification “rules” may change as well as its’ *effect*. In this study, we support the fact that ‘students learn, behave and act in different ways’ [8] and believe that the reason for these “different effect” lies exactly in students' diversity. If learners approach learning in different ways, it has sense to believe that they will approach gamification differently, as well.

The successfulness of gamification will depend on students’ diversities, in other words, game elements should be implemented based on students’ learning characteristics. In this manner, this thesis aims to recognize different STEM students’ learning profiles and incorporate gamification based on them.

3 Background and related work

In recent years, there has been an increasing interest in applying game-related principles in TEL. Current researches have already confirmed gamification to be powerful applications for improving both formal and informal learning experience [6]. In addition, some of the widely known educational platforms such as MOOCs¹, Moodle², and Duo Lingo³ are already providing gamified courses with various game elements such as badges, leaderboards, experience point, avatars etc. [4]. On the other hand, researchers also found many contradictions and un-answered questions when it comes to how and to which extend gamification can influence learning process [9]. Recently, researchers suggest personalized e-learning as “the safest” environment for successful incorporation of game elements in education as it aims to gamify content in relation to the behavioral, motivational and cognitive characteristic of the user. It is a so-called Gamification 3.0, which “combines the power of big data, behavioral insights, plus elements

¹ A massive open online course (MOOC, <http://mooc.org/>)

² Moodle is a free and open-source learning management, <http://moodle.org/>

³ Duo lingo is a freemium language-learning platform that includes a language-learning website and app <https://www.duolingo.com/>

of psychology and neuroscience to understand a user's activities, behavior and frame of mind" [10].

Current researches reveal that personalized gamification is growing in importance, but still, most of the available work is only theoretically oriented. For example, in [11] authors developed an algorithm that, based on students' behavior and their profile types, provides different game elements and gamification tasks to users in real-time. They've created a software for personalized gamification, still, empirical evidences or studies on their model were not given. Similar to, in [12] authors proposed a theoretical framework of personalization in gamification. They presented and established relationships between game genres, learning techniques and learning styles and give suggestions on which game genres could answer which learning style needs.

In relation to the prior theoretical funding's, in 2017, we have proposed a model for gamification in personalized learning environment based on students learning style – LSGM [13]. In this model, we aimed in finding a relationship between different students' profiles (characterized by the Felder-Silverman learning style model (FSLSM)) on the one side, and game elements on the other side. Since we aim to provide gamified environment for STEM students, we used the FSLSM for clustering different user types, as the most commonly used model for engineering students [14]. Results of our experimental model were promising since we found statistically significant interconnections between learning styles, game elements and they mutual influence [15]. However, being aware of numerous critics on learning styles, their debatable effect and applicability in learning process, and the fact that they should not be seen as a standalone indicator for user profiling [16] the reconsiderations of the LSGM model needs to be further investigate.

Hence, this doctoral dissertation aims to expand the model by introducing deeper students' characterization, which will include their pre-knowledge test and ILS⁴ results as well as their behavior and action taken during the course. Further, the reconsideration of game elements that a personalized e-learning programming course should contain will be taken into account.

4 Thesis statement

This thesis addresses the lack of engagement and participation in e-learning programming language courses in higher education at STEM universities. The main goal of this thesis is to use gamification for boosting engagement and participation in course based on predefined students' profiles. The main problem we are seeking to solve requires systematic research procedure, in which we aim to find answers to the following:

- P1: What kind of different students' learning profiles can be recognized in e-learning course?
 - P1.1 are there any differences between students' learning profiles in gamified and non-gamified environment?

⁴ Index of Learning style questionnaire, used to determinate learning styles based on FSLSM

- P2: How can we incorporate gamification in e-learning course, in order to satisfy the needs of a certain student learning profile?
 - P2.1 what are the needs of ones learning profile?
 - P2.2 which game elements should be used?
- P3: What effect a game element can generate in learning experience on a certain learning profile?
 - P3.1 what effect a game element can produce in general?
 - P3.2 which factors influence students' engagement, participation and interest, in general?
- P4: What are the general principles and rules that should be followed when gamifying personalized e-learning environments?

5 Research goals and methods

This research aims to provide a suitable e-learning environment in which game elements are implemented based on students' learning profiles, in order to keep students engaged, encourage continuous learning and make learning more enjoyable. In further text, we present our main goals (G), corresponding research method (RM) as well as measures and contributions.

- G1: Provide gamified e-learning activities and tasks in correlation with different students' learning profiles.

RM1: Based on the results obtained from the first-year experiments we will personalize an e-learning course so it can respond to different students' needs and requirements. Game elements that will be applied are those that are, in the state-of-the-art, singled out as the most effective and commonly used ones. The result of this phase is the prototype of gamified, personalized e-learning course.

- G2: Improve learning outcomes, increase productivity, successfulness, satisfaction and engagement among STEM students.

RM2: In order to be able to measure how and to which extend game elements made impact on students we will divide students in two groups: experimental and control. Experimental group is the one who will attend gamified personalized learning course, while the control group will attend the personalized course without game elements. Comparative results (between and inside the groups) will be measured using different data and instruments such as pre-knowledge and self-assessment tests, ILS and opinion questionnaire etc.

- G3: Set a platform independent guideline for introducing game elements in personalized e-learning environments.

RM3: In creation of game elements and personalized learning content, we will use popular techniques and languages such as PHP, JS, HTML, and CSS so that they can be easily integrated and used in any Learning Management System. This phase will results

in specific technical and theoretical guidelines on how to incorporate game elements based on students' learning profiles, as well as which effects and results can be expected.

6 Dissertation status and planned activities

Our planned future work is set around period of two years. Unlike the first year, in which we mostly focused on literature review and conceptual model, for the remaining period we plan to focus on evaluation and experiments. In this regard, we will conduct a two-step experiment with students at RWTH Aachen University. The idea is to first, personalize the course based on the findings from first year literature reviews and then implement game elements. After two iterations, evaluation and analyzes of the successfulness we aim to create gamified personalized platform. This e-learning platform should provide learners with gamified materials and activities that fit their learning references and needs. After the implementation, we will validate and verify the usefulness and usability of such platform, and, if necessary, make improvements. At the very end, last few months of planned period will be dedicated to final thesis writing. The methodology of the doctoral thesis will be conducted through various working packages shown in Figure 1.

Activities	2018			2019												2020									
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	
Work Package I																									
a. Conducting the experiment	■	■	■																						
b. Data analyzes			■	■	■																				
c. Modification and evaluation based on analyzes results				■	■	■																			
Work Package II																									
a. Re-Conducting the experiment							■	■	■																
b. Data analyzes and comparisons									■	■															
Work Package III																									
a. Developing of personalized gamified e-learning environment													■	■	■	■									
Work Package IV																									
a. Validation and verification of gamified platform																	■	■	■	■					
Work Package V																									
a. Writing PhD thesis																									

Fig. 1. Working packages time snaps for planned activities

7 Expected contributions

The work in this thesis contributes to the empirical knowledge concerning the application of gamification in personalized e-learning environments. Its focus is set around investigation of different students' learning profiles, and finding the way to use game elements in order to fulfill students' needs and support their learning characteristics. By creating a personalized gamified e-learning course, we expect to help students stay engaged and motivated through enhancing their competitive spirit and strengthen the desire for mastering the curricula. On the other hand, we expect professors to welcome this platform, primarily, as a tool for creating interesting materials and interactive ways of assessment. Further, the proposed approach can serve as a strong base for building an adaptive gamified e-learning platform, where potentially large communities of

teachers, lecturers, academics are empowered to create gamified educational content in a truly collaborative way.

This kind of approach to education, where the emphasis is on finding innovative ways to overcome the learning obstacles, can get us closer to an educational system that continuously produces quality staff, without the need for lowering the criteria in order to maintain the quantity of enrolled and graduated students.

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