

Measurement of the effects of e-learning courses gamification on motivation and satisfaction of students

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Abstract - In this paper, we present the results of a study which was conducted in two stages. The first part of the paper contains literature search findings and analyzes the existing self-assessment scales for measuring motivation and satisfaction of students that were developed by other authors. In the second part of our study we created a battery of self-assessment measures for collecting data for an overarching set of gamification-related constructs/variables selected in accordance to those that are reported in literature). These scales were constructed by (a) adaptation and improvement of items from existing measures and (b) creation of novel items for measures of constructs that were found to be important in research articles on gamification and educational games. The initial empirical evaluation of this new questionnaire (battery of assessment scales) was performed on a large convenience sample of students (N=201) who attended a hybrid course on computer programming. These respondents were divided into an experimental group, which used gamified e-learning course material, and a control group, which used a parallel (non-gamified) version of the e-learning course with equal theoretical content. For each self-assessment scale of the questionnaire Cronbach alpha coefficients were calculated and the scales were slightly corrected to improve their internal consistency. We report the results concerning the effects of gamification on motivation and satisfaction, which were measured by respective assessment scales.

Key words - e-learning, gamification, motivation, satisfaction with e-learning, game elements, self-assessment, questionnaire

I. INTRODUCTION

Gamification is a popular construct which denotes the introduction of elements that are characteristic of game playing (points, rules, competition, levels, progress monitoring, community, ranking of players, reward systems, etc.) to areas that are not games (or originally did not include game playing) for the purpose of making a specific activity more interesting, motivating, and engaging for participants. As in many other areas (marketing, health promotion, work productivity, finance, government) a serious potential for the use of gamification in education, in particular in e-learning, has been recognized. It must be emphasized that since 2011 the interest in the use of gamification in e-learning has been growing rapidly.

A brief analysis of scholarly literature with the use of the Google Scholar search engine indicates that in the 2011-2017 period there was a greater than tenfold increase in the interest in the use of gamification in e-learning (see Figure 1).

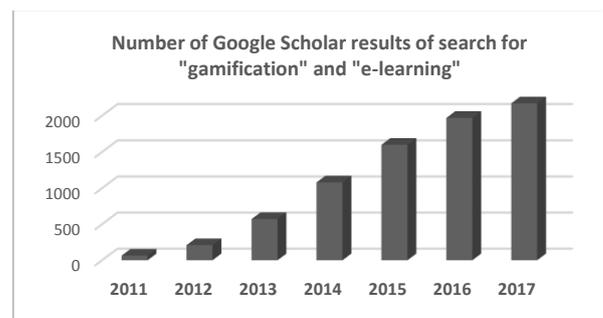


Figure 1. The results of using Google Scholar and key words "gamification" and "e-learning" in academic literature search (February 2018)

A. Review studies and meta-studies on gamification

A review performed by Dicheva et al. [1] on the application of gamification in e-learning revealed that most of the analyzed studies were related to courses on (a) *Computer Science* or (b) *Information Technology*. They found that the benefits of gamification that were reported in literature were mostly associated with higher engagement of students in learning activities, increased attendance and participation, increased quantity of students' contributions/answers (without a reduction in quality), and an increased percentage of passing students. However, the authors of that study concluded that the majority of reviewed publications only described specific mechanisms and dynamics of gamification and/or discussed their possible use in the educational context, while the effectiveness of gamification regarding learning outcomes was dealt with in only few quality empirical studies.

In a recent and more detailed inspection of methodological issues and outcomes of studies related to the use of gamification in education Dichev and Dicheva [2] established that, beyond its proven potential to enhance learning environments, there was not enough evidence that gamification produces long-lasting educational outcomes and yields better performance than traditional educational models. However, these authors emphasized that most of the studies (79%) in their analysis were related to affective, behavioral and/or cognitive outcomes, which highlights the importance of adequate measurement of the related sets of constructs.

Clark et al. [3] pointed out the very demanding nature of the assessment of complex variables in the related field of serious games and also stated that "higher order cognitive, intrapersonal, and interpersonal processes and skills prove

more challenging to measure accurately and reliably than do lower order cognitive skills and rote knowledge.”

B. Motivation in educational games and gamification

Recent research on the motivational effects of specific gamification elements has advocated the need for differential analyses of the effects of particular gamification elements on the functioning of individuals instead of searching for the general effect of gamification *per se* [4]. For instance, in a study by Suh et al. [5] the authors adapted a set of measurement scales related to motivation and needs satisfaction constructs. Their recommendation was not only to assess the effects of points, leaderboard and badges in analyses of gamification outcomes, but also to investigate psychological constructs like self-expression, competition, and altruism, as well as their effects on needs satisfaction.

The importance of motivational variables was also indicated by an intriguing study by Hanus and Fox [6], who found that over time the students in the *gamified* course showed *less* motivation, satisfaction, and empowerment in comparison to the students in the equivalent *non-gamified* course.

An interesting literature review by Peixoto and Silva [7] listed more than 200 gamification requirements for educational software. Some of the requirements were related to players' personality traits, while those related to objectives of gamification implementation were aimed at increasing and facilitating engagement, motivation, involvement, proactive attitude, interaction, participation, collaboration, satisfaction, etc. It must be noted that, in order to measure the fulfillment of those requirements in a gamified course, specific response scales need to be constructed.

Despite the growing popularity of practical application of gamification, several meta-studies have failed to produce unquestionable evidence of its effectiveness. In their meta-study Hamari et al. [8] found that, according to the results of several studies, the effect of gamification may not be long-term and could be associated with the novelty effect. However, most of the studies that they reviewed *reported positive effects of gamification on some aspect of motivation*.

II. ASSESSMENT OF MOTIVATION RELATED VARIABLES IN SERIOUS GAMES AND GAMIFICATION STUDIES

Diverse constructs have been used by various authors to create scales to measure the effects of e-learning courses, gamification of instruction, educational games and video games on users/students. These constructs can be grouped into the following categories: (1) general course evaluation, (2) perceptions of the learning system/environment, (3) evaluation of user interface and flow, and (4) learners' motivation variables. Some of the investigated constructs and related authors are listed here in chronological order (including the year of publication):

- Impact of self-determination theory on motivation in e-learning (Sørrebø et al., 2009 [9]);
- Learners' enjoyment of e-learning games (Fu et al., 2009 [10]);

- Impact of media richness and flow on e-learning technology acceptance (Liu et al., 2009 [11]);
- Users' experience of video games (Parnell et al., 2009 [12]);
- Core elements of gaming experience (Calvillo-Gómez, 2010 [13]);
- Facets of students' expectations and experiences related to perceived learning achievements and course satisfaction (Paechter et al., 2010 [14]);
- Students' satisfaction with hybrid learning regarding preconceived and informed expectations (Pinto and Anderson, 2013 [15]);
- Students' flow experiences in an online learning environment (Esteban-Millat et al., 2014 [16]);
- Dispositional flow in education (Hamari and Koivisto, 2014 [17]);
- Determinants of satisfaction and continuous use intention in e-learning services (Pereira et al., 2015 [18]);
- User experience video game satisfaction (Phan et al., 2016 [19]);
- Antecedents and consequences of flow in e-learning (Rodríguez-Ardura and Meseguer-Artola, 2017 [20]).

Much of the research on gamification is related to and preceded by investigation of video games and serious (educational) games. For instance, Parnell et al. [12] developed a scale for prediction of game appeal and another scale for assessing game quality with the following four subscales: Affective Experience; Focus; Playability Barriers; Usability Barriers. In a similar study Fu et al. [10] designed a 42-item scale for the measurement of learners' enjoyment in e-learning games with the following 8 subscales: Concentration; Goal Clarity; Feedback; Challenge; Control; Immersion; Social Interaction; and Knowledge Improvement. In a more general study related to e-learning Paechter et al. [14] investigated students' expectations, experiences and course satisfaction using a questionnaire with the items related to course design, interaction with the instructor, interaction with peer students, individual learning processes, and learning achievements or course outcomes. Finally, Calvillo-Gómez et al. [13] introduced an instrument for measuring gaming experience with the following 10 scales: Enjoyment, Frustration, Core Elements of the Gaming Experience, Puppetry, Video-game, Control, Facilitators, Ownership, Game-play, and Environment.

For the purpose of the study that is presented in this paper the scales and specific items that were created by the previously mentioned researchers were combined and reformulated to create a set of measures of constructs that are more specifically associated with gamification of e-learning courses.

III. METHOD

A. Research questions

The application of gamification in e-learning is attracting great interest despite the lack of quality experimental studies

examining its effectiveness (see: [1]). Furthermore, a study by Peixoto and Silva [7] indicated the need for the development of measurement instruments that could be used to evaluate numerous gamification requirements and objectives for using gamification.

In accordance with the theoretical issues previously outlined in the introduction section, two main research questions (RQ) were defined for our study:

RQ1: Is it possible to develop a set of assessment scales to measure distinct constructs related to the process of using a gamified e-learning course, learners' experience and satisfaction, as well as their evaluation of the course.

RQ2: Does the use of a *gamified* e-learning course module (in the *experimental* group) in comparison to the use of a *non-gamified* e-learning course module (in the *control* group) have an effect on learner' evaluation of the process of using a gamified e-learning course, their experience and satisfaction, as well as their evaluation of the course in general.

B. Subjects

The subjects in our study were students of the second year of the undergraduate study of information systems at a Central European university who were enrolled in a hybrid Programming course. The total number of respondents who volunteered for the study was 201. Out of the total number of respondents, 44 (or 21.9%) were female and 157 (or 78.1%) male. The average age of respondents was 20 years. However, the survey questionnaire was correctly completed by 182 students. Among those 182 students, 87 were assigned to the *experimental* and 95 to the *control* group.

C. Instruments

The main instruments in our study were a *pre-test* and *post-test* of knowledge of a specific programming topic ("Batch and Stack"), as well as a *survey* with demographic questions and carefully chosen scales for the assessment of gamification related processes, experiences and perceptions of the e-learning course. It should be noted that for the purpose of the study two parallel e-learning course modules with identical teaching materials were designed on the "Batch and Stack" topic.

The *pre-test* consisted of 30 items with 25 closed and 5 open-ended questions related to the general topic of programming. The *pre-test* was applied on the initial group of 201 students. Based on the results of the pre-test the subjects were divided in the experimental and control group. The *post-test* consisted of 32 items with 26 closed and 6 open-ended questions related to the content of the e-learning course module "Batch and Stack". The *post-test* was applied on 192 students (96 from the *experimental* and 96 from the *control* group).

The *survey* consisted of demographic questions and items related to the use of internet technology (in the *first* part), scales for the assessment of the process of gamification and students' evaluation of the e-learning course attributes (in the *second* part), as well as of items related to students' perception of specific gamification elements (in the *third* part). The labels for the scales in the second part of the survey and sample items from each scale are listed in *Table 1*.

TABLE 1. SCALE LABELS AND SAMPLE ITEMS FOR EACH SCALE IN THE SECOND PART OF THE SURVEY

| Scale label | Sample item |
|--|--|
| Satisfaction with e-course | "I thought that the e-course was fun." |
| Navigation / overview of the e-course | "I always knew where to go in the e-course." |
| Feedback within the e-course | „I received sufficient feedback about my results during my use of the e-course." |
| Enjoyment / preoccupation with e-course | "I was focused on the tasks of the e-course." |
| Instructions for use / menus, settings, help | "The instructions for menus and other functionalities were clear and detailed enough." |
| Adequate difficulty of e-course | "The level of difficulty of the e-course was right for me." |
| Motivational incentives | "I used the e-course well because it was motivating for me." |
| Interaction with other learners | "The cooperation with other participants in the e-course was helpful for my learning." |
| Learning achievement | "The e-course motivated the player to integrate the knowledge taught." |
| Self-paced and flexible learning | "The e-course enabled me to use my own choice of strategy and pace of learning." |
| Personal experience with e-course | "I liked the way the e-course looked." |
| Evaluation of e-course | "I think that working with this e-course was important for my knowledge." |

The *e-learning course* module which was used by the *experimental group* of subjects included numerous gamification elements based on the model developed according to the *Octalysis Gamification Framework* [<http://yukaichou.com/gamification-examples/octalysis-complete-gamification-framework/>]. These gamification elements were added as plugins in the Moodle learning management system.

The gamification elements included in the e-course "Batch and Stack" for the *experimental* group included a simplified graphic user interface, dynamic graphic interface, story as an introduction to the e-course, links to social networks, tasks and challenges, visual display of tasks/duties, collecting points, progression through the e-course, badges, status of e-course completion, collaboration, leaderboard, elements of surprise, countdown or remaining time, feedback, educational games, etc. However, the e-learning course that was used by the *control group* of subjects used only a traditional non-gamified online course with equal course related learning content in the Moodle system. This traditional non-gamified version of the course "Batch and Stack" had only three gamification-related elements: profile and avatar area, use of forums, and nonlinear access to educational materials.

D. Procedure

The subjects in our study were full-time students enrolled in an undergraduate hybrid Programming course. That means that they regularly attended classroom lectures and exercises in the computer laboratory but also had access to online course material that was placed in the Moodle learning management system. For the purpose of our study a separate Moodle course material was developed on the “Batch and Stack” topic in the Programming course. In fact, a gamified and a more traditional non-gamified parallel version of this module were placed.

Before implementing the e-learning course “Batch and Stack”, the students were assessed with the *pre-test* to ensure that there would be no difference in prior knowledge between the experimental and control group. Then both the *experimental* and the *control* group used the e-learning course for 2 weeks. Finally, a *post-test* and a *survey* were applied.

IV. RESULTS

A. Internal consistencies (Cronbach alpha) of scales related to learners’ experience and satisfaction

A pilot study was conducted to test the gamification related elements of the e-learning course module “Batch and Stack” and an initial version of the survey. However, due to limitations of space in this paper it is not possible to describe it in detail. The scales of the survey for the measurement of distinct constructs related to the process of using a gamified e-learning course, learners’ experience and satisfaction, as well as their evaluation of the course were once more investigated after the application of the survey on the 182 subjects in the study described in this paper. After the items of several scales of this survey had been excluded due to their low item-total correlation, the final Cronbach alpha for all the scales was calculated (see Table 2).

As can be concluded from the data presented in Table 1, all of the scales that were used in our study manifested a satisfactory level of internal consistency measured by the Cronbach alpha coefficient (i.e. ranging from .767 to .931). It must be noted that the items of those scales originated from various sources, as well as that the original items of the scales were articulated in the context of video games or educational/serious game and therefore had to be rephrased to the context of gamification of e-learning courses.

To verify that each of the scales measures a separate construct, a *confirmatory factor analysis* was performed with *varimax* rotation and a fixed number of factors which corresponded to the number of scales. The results of this factor analysis indicated that each of the scales has the largest projection on a unique/separate factor, which makes it sufficiently specific regarding the respective construct and different in terms of the object of measurement in comparison to other scales.

The value of Cronbach alpha coefficients that are presented in Table 2, as well as the previously mentioned results of the confirmatory factor analysis permit the following conclusion regarding the first research question

(RQ1): It is possible to develop a set of assessment scales to measure distinct constructs related to the process of using a gamified e-learning course, learners’ experience and satisfaction, as well as their evaluation of the course.

TABLE 2. SCALE LABELS, NUMBER OF ITEMS PER SCALE, CRONBACH ALPHA COEFFICIENTS AND SOURCE OF ITEMS IN SCALE

| Scale label | Number of items | Cronbach alpha | Initial versions of items [source] |
|--|-----------------|----------------|------------------------------------|
| Satisfaction with e-course | 9 | .858 | [12] |
| Navigation / overview of the e-course | 11 | .903 | [12], authors |
| Feedback within the e-course | 4 | .904 | [10] |
| Enjoyment / preoccupation with e-course | 12 | .856 | [12], [10] |
| Instructions for use / menus, settings, help | 6 | .767 | [12], [10], authors |
| Adequate difficulty of e-course | 7 | .782 | [12], authors, [10] |
| Motivational incentives | 4 | .835 | [14], [12], authors |
| Interaction with other learners | 9 | .919 | [10], [14], [12] |
| Learning achievement | 9 | .867 | [10], [14], authors |
| Self-paced and flexible learning | 7 | .859 | [14], authors |
| Personal experience with e-course | 9 | .810 | [13] |
| Evaluation of e-course | 24 | .931 | [21] |

B. The effect of gamification on students’ achievement in an e-learning course

To examine the effects of gamification on students’ learning of the content of the e-learning course module on the topic “Batch and Stack”, a *t-test* was performed on the results of the *post-test* of the *experimental* and *control* group of subjects. The data in Table 3 confirms that the students in the *experimental* group, which used a *gamified* version of this e-learning course module, had a statistically significantly *greater average score* in the *post-test* in comparison with the *control* group, which used a *non-gamified* parallel e-learning course module with only several gamification related elements (profile and avatar area, use of forums, and nonlinear access to educational materials).

TABLE 3. STATISTICAL SIGNIFICANCE OF DIFFERENCE IN POST-TEST KNOWLEDGE BETWEEN EXPERIMENTAL (NE=96) AND CONTROL (NC=96) GROUP OF SUBJECTS WHO TOOK THE POST-TEST

| Group | N | Mean | σ | t | p |
|--------------|----|-------|------|------|--------|
| Experimental | 96 | 13.89 | 5.42 | 2.68 | 0.0079 |
| Control | 96 | 12.03 | 4.05 | | |

It must be noted that the average test score in the *post-test* is greater for the *experimental* group than the average test score for the *control* group and the difference is statistically significant at the level of $p < 0.01$. However, the *actual difference* in the average score is less than 2 points (out of possible 32 points in the post-test). Therefore, despite the great additional effort to gamify the e-learning course module “Batch and Stack”, the real and measurable effects of gamification in form of greater learning achievement, although positive, are not impressive and do not demonstrate a proportional return regarding the investment in technology innovation and time for preparation and implementation of this rather demanding teaching activity.

C. Comparison of evaluation of learners' experience and satisfaction with e-course in relation to gamification

The previously presented results of gamification on learning achievement in the experimental group are not the only measurable positive effect. Other effects of gamification can be related to satisfaction with the e-learning course, greater level of enjoyment and preoccupation with learning activities, more positive personal experience, and better evaluation of the gamified e-learning course in comparison to more traditional design of e-learning courses. The data presented in *Table 4* illustrates the observed differences between the experimental and control group regarding the evaluation of various attributes of the gamified and non-gamified versions of the e-learning course “Batch and Stack”, as well as perceptions of satisfaction, enjoyment, and learning achievement.

As can be concluded from the data presented in *Table 4*, the gamified version of the e-learning course was on average much better evaluated regarding the variables measured by the scales “Feedback within the e-course” and “Self-paced and flexible learning”, as well as in relation to the construct measured by the scale “Interaction with others”. Also, the gamified version of the e-learning course was on average slightly better evaluated (with statistical significance) in relation to variables measured by the scales “Motivational incentives”, “Satisfaction with e-course” and “Enjoyment/preoccupation with e-course”, as well as “Personal experience with e-course” and “Evaluation of e-course”. Finally, in case of the average scores for the scales “Instructions for use/menus, settings, help” and “Learning achievement”, the gamified version of the e-learning course also received higher evaluation.

On the basis of the results presented in *Table 4* a conclusion can be made regarding the second research question (*RQ2*): The use of a *gamified* e-learning course (in the *experimental* group) in comparison to the use of a *non-gamified* e-learning course (in the *control* group) had a predominantly positive effect on learners' perceptions and evaluation of various variables related to the process of using a gamified e-learning course, experience and satisfaction with this course, as well as the general evaluation of the gamified e-learning course.

TABLE 4. STATISTICAL SIGNIFICANCE OF DIFFERENCE IN AVERAGE SCORES OF ASSESSMENT SCALES RELATED TO EVALUATION OF COURSE ELEMENTS, MOTIVATION, ENJOYMENT AND SATISFACTION BETWEEN THE EXPERIMENTAL (NE=87) AND CONTROL (NC=95) GROUP OF SUBJECTS WHO CORRECTLY FILLED OUT THE SURVEY

| Scale label | M _E | M _C | σ _E | σ _C | t | p |
|---|----------------|----------------|----------------|----------------|--------------|-------------|
| Satisfaction with e-course | 3.05 | 2.86 | 1.14 | 1.05 | 3.59 | 0.00 |
| Navigation / overview of the e-course | 3.19 | 3.09 | 1.23 | 1.19 | 1.76 | 0.08 |
| Feedback within the e-course | 3.98 | 2.89 | 0.84 | 1.17 | 14.26 | 0.00 |
| Enjoyment / preoccupation with e-course | 2.97 | 2.67 | 1.07 | 1.11 | 6.36 | 0.00 |
| Instructions for use / menus, settings, help | 3.54 | 3.20 | 1.13 | 1.16 | 4.92 | 0.00 |
| Adequate difficulty of e-course | 3.16 | 3.10 | 1.19 | 1.14 | 1.03 | 0.30 |
| Motivational incentives | 3.54 | 3.02 | 0.97 | 1.02 | 6.98 | 0.00 |
| Interaction with other learners | 3.31 | 2.75 | 1.00 | 1.16 | 10.37 | 0.00 |
| Learning achievement | 3.64 | 3.34 | 0.83 | 1.00 | 6.52 | 0.00 |
| Self-paced and flexible learning | 3.90 | 3.00 | 0.91 | 1.12 | 15.64 | 0.00 |
| Personal experience with e-course | 3.42 | 3.21 | 1.16 | 1.05 | 3.80 | 0.00 |
| Evaluation of e-course | 3.29 | 3.01 | 1.13 | 1.10 | 8.98 | 0.00 |

* M – arithmetic mean; σ – standard deviation; t – t-test value; p – level of statistical significance of t-test; E – experimental group; C – control group; statistically significant differences are written in boldface

V. CONCLUSION

The main goal of the research presented in this paper was to investigate various effects of gamification of e-learning courses on students. For this purpose a collection of assessment scales was required and, after literature search, a number of scales was developed by combining the (a) adaptation of items from scales of other authors and (b) creation of new items. The scales were first tested in a *pilot study* and then applied once more on 182 subjects who were enrolled in a Programming undergraduate university course. All of the evaluated scales manifested good internal consistency (Cronbach alpha) and can be used for similar research topics (see *Table 2*).

The subjects in our study were divided in an *experimental* group, which used a *gamified* version of an e-learning course module “Batch and Stack”, and a *control* group, which used a

non-gamified version of the same e-learning course module. Both groups used this course module for a period of two weeks. The *post-test* indicated that the *experimental* group achieved slightly higher average scores in comparison to the *control* group (see *Table 3*). In addition, the *experimental* group valued most attributes of the gamified e-learning course module more favorably in comparison to the evaluations of the non-gamified course by the control group (see *Table 4*). Also, the experimental group which used the gamified version of the e-learning course module “Batch and Stack” reported a higher level of satisfaction with the e-course, greater enjoyment and engagement with the e-course, and greater learning achievement.

It can be concluded that the effects of gamification should not be measured only by the difference in learning effectiveness, but also with regard to the experience of learners with the online courses, their level of motivation and satisfaction. The gamification of e-learning courses has the potential to create a more interesting, motivating, engaging, enjoying and collaborative virtual environment, which may compensate for the occurrences when the learning effectiveness of an e-course is in disparity with the investment of instructors’ time, effort and engagement in technological innovation.

With numerous elements that can be used in gamification it is necessary to evaluate their respective influence on learning outcomes and learners’ experience (see [22]). Moreover, in each practical application of gamification the potentially negative effects must be studied despite the commonly positive general expectations of instructors (for example, see: [23]).

As was discussed in the “Results” section of our paper, the measurable effects of gamification in form of greater learning achievement were not impressive in comparison to the time and effort for the preparation and implementation of this type of online course. Iosup and Epema [24] had a similar observation regarding their research on the effects of gamification of two computer science university courses. They found that it may present a challenge for instructors who need advanced skills for the use of gamification pedagogy and technology. Furthermore, large-enrollment courses may need computer-assisted management of bonuses and explanation of gamification is needed for new students. Finally, there could be some organizational inertia in acceptance and limited university support for successful implementation of gamification. It must also be noted that for a variety of reasons the attitudes of teachers toward game based learning may not necessarily be positive [25].

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