A Game-like Online Student Assessment System

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Abstract

The paper introduces a web application for student assessment in any subject area which implements an original game-like scheme to improve students' engagement and fun, as well as to reduce their examination stress. The proposed scheme capitalizes more on the fear of failure rather than on reward collection and player status, thus resembles more video games than known educational systems featuring gamified assessment. The first obtained results of the survey-based evaluation of the tool show that it has met its goals of instilling fun and engagement and can be considered applicable to various forms of assessment, providing grounds for future work on analyzing the tool's effects on learning.

Keywords: online assessment, gamification, web applications, educational software.

1. Introduction

While the connection between games and education was strong in the ancient world [1], the two diverged markedly in the modern times of compulsory education. The latter served well the needs of societies in the age of industry, but the age of information calls for educational solutions of a different character [2]. Following the call attributed to Johan Huizinga ("Let my playing be my learning, and my learning be my playing" [1, p. 1]), there is considerable interest in closing the gap between games and education. This interest is grounded in merits: Mayo who elaborates on the educational advantages of video games gives several reasons advocating for her stance, one of which is the games' compatibility with the effective learning paradigms: experiential learning, inquiry-based learning, self-efficacy, goal setting, cooperation, continuous feedback, tailored instruction, and cognitive modeling [3].

While game-based learning uses full-fledged games as educational tools, since around 2010, another way of exploiting games in education has risen in popularity [4]: gamification, which makes use only of selected game design elements, implemented in real-world contexts for non-gaming purposes [5]. Despite inferior in immersiveness, gamification comes useful whenever full-fledged games are unsuitable for formal, technical, or sociological reasons. While it is always challenging to develop an educational game that, at the same time, would be effective in achieving the envisaged learning objectives, would adhere to contemporary technical standards and esthetic norms, and which its intended users would be willing to play, a gamification layer can be easily added to almost any educational application. Nonetheless, a shallow form of gamification, often confined to the triad of just three game design elements (points, badges, and leaderboards) and thus dubbed pointsification [6], is criticized for "misrepresenting games" and usually focusing only on positive reinforcement, "leaving out the pain and loss of failure" without which "the emotional thrill of gaming is lost" [7, p. 03]. The opposite of pointsification is meaningful gamification in which gameful and playful layers are used to "help a user find personal connections that motivate engagement with a specific context for long-term change" [8, p. 1].

In this paper, we propose an application of meaningful gamification in the form of an educational tool for online assessment – which is most often a target of shallow gamification. Before we describe the concept of the tool (in Section 3) and its software implementation (in Section 4), we make a short review of related work on gamified tools for online assessment (in Section 2). The tool was subject to evaluation by students and its results are presented in Section 5, whereas the final section concludes the paper.

2. Related Work

The gamified online assessment tools have received some interest from the scientific community. Table 1 lists the seven gamified online assessment tools covered by the identified relevant literature. Note that it only includes tools for an online assessment of any teaching subject – not the tools designed for online assessment of specific subjects only, e.g., computer programming [9].

Table 1. Existing gamified tools for online assessment.

Name	Address	Selected publications
Kahoot!	https://kahoot.com/	[10] [12] [13] [15] [16] [17] [18]
Oodlü	https://oodlu.org/	[11]
Plickers	https://get.plickers.com/	[13] [14] [17]
Quizalize	https://quizalize.com/	[10] [11] [17]
Quizizz	https://quizizz.com/	[10] [12] [15] [16] [17]
Quizwhizzer	https://quizwhizzer.com/	[11] [16]
Socrative	https://socrative.com/	[13] [16] [17]

Several works confirm the suitability of gamified student response systems for supporting education of various subjects (English language [16,17], finance and international trade [13]) or in various educational contexts (e.g., off-line in-class education [14]). One work reports "significantly higher student motivation, enjoyment, and encouragement to collaborate" in comparison to a non-gamified student response system [18], another one reports mixed results with regard to learning effects, finding one tool to improve and another to impair students' academic achievement [12].

In three works, the functionality of available gamified student response systems is compared (two in [15], four in [16], and five in [17]) to suggest the most functional gamified tool for student assessment.

All tools listed in Table 1 are primarily student response systems, capable however to be run outside of the classroom (hence useful for various forms of assessment). The set of applied gamification elements they are enriched with varies between tools, however, we can find the following six elements in all of them (note we follow here the nomenclature for gamification elements proposed by Marczewski [19]):

1. Challenges – consisting in questions to be answered.
2. Curiosity – as the questions are revealed one by one, and the right answers are revealed only after the last student has answered or the time has passed.
3. Time Pressure – as the questions have to be answered in a limited time, and among the right answers, the better is the one given first.
4. Points – as the right answers are awarded with points.
5. Competition – as the students try to provide the right answers for the most questions in the shortest time.
6. Leaderboards – showing how well each player fares compared to others.

Although there are other gamification elements implemented in some of the tools, the whole gamification scheme is rather shallow and the assessment does not differ much from non-gamified tests administered, e.g., with Moodle, where at least challenges, curiosity, time pressure, and points are also present. Gerber calls such an approach "the biggest miss in the current gamification trend" because it overlooks "the importance of players' meta-awareness for failure" requiring them "to reflect on why something did not work the first time and then adjusting one's practice to progress" [20, p. 89]. As observed by Cain and Piascik, in well-designed games, "failure is not only acceptable, it is

expected", allowing the learner to view failure “more as an opportunity for further learning” [21, p. 3-4]. In the following section, we propose a new game-like online assessment form addressing this deficiency of existing solutions and, subsequently, a new examination information system featuring it is presented and evaluated.

3. Game-like Assessment: Concept

Instead of adding gamification elements to an online test tool, our idea was to develop a game consisting in answering test questions. For this reason, our concept is primarily based on a fundamental game design element which can be found in most video games but is hardly ever used in gamification: player’s life.

Students start the assessment with their life meter set to 100%. Alike the tools described in section 2, every good answer gives points to the player, yet unlike them, every wrong answer reduces the player’s life meter by 15% (of the initial life, not the current life). Whenever players do not answer before the time passes (in 60 seconds by default), their life meter is reduced by 10%, the same if they pick the option “I don’t know”. When the player’s life meter drops to 0%, the assessment is over. The final grade (deciding if the test has been passed or failed) depends on the number of points at this moment (though not directly, this will be described later with a finer grain of detail). The other way of finishing the assessment is by staying alive till the last question has been answered.

Note that in contrast to the other tools, where motivation is mostly based on the anticipation of rewards (points awarded for right answers), here fear-based motivation is also exploited (the player being afraid of losing the game for wrong answers), which should induce more engagement and thus help students stay focused on the test.

Like video games, the proposed tool generates instant feedback, showing a success/failure message along with the current player status after each answer. The presented messages have attached corresponding images evoking emotions, both positive (displayed at the beginning of the assessment, after every good answer, and at the end of the assessment if the student has passed) and negative (displayed after every wrong answer and at the end of the assessment if the student has failed). Unlike video games, as the tool can also be used in the classroom where silence is needed to not disturb other students, there are no relevant sound effects or music scores attached to the respective displayed images.

In order to extend the students’ range of possible action beyond answering the question, there are two additional actions, each of which could be used just once in one test: option check (which verifies whether the currently selected option is right or wrong) and time extension (which gives more time to answer the current question, extra 45 seconds by default). This helps students deal with the most difficult questions at the same time allowing them to make some strategic decisions (whether to perform a specific action on the current question or keep it expecting an even harder question to come later).

As mentioned earlier, the final grade in the test only indirectly depends on the gathered points, as it depends directly on the level attained by the student. As the students progress with the number of collected points, their level rises. There are three levels in the game. Players begin at level 1 which means failure if they remain at this level at the end of the assessment. The player progresses to level 2 after having correctly answered 7^{th} question – if, for the sake of simplicity, we ignore the time-outs, considering that 7 wrong answers are needed to zero the player’s life meter, this means that the minimum number of questions that the player must answer to pass the test is 14 with the ratio of good answers of 50%. Level 2 guarantees the student a passing grade. Once achieved, it cannot degrade back to level 1. The player attains the top level (3) after correctly answering 10 questions at level 2. Level 3 guarantees the student a good grade. If, for the sake of simplicity, we ignore the time-outs, this means that the minimum number of questions that the player must answer correctly to achieve a good grade on the test is 24 with a ratio of good answers of 70%. Only students whose ratio of good answers reaches or surpasses 90% at the end of the test receive a very good grade.

Note that the inability to lose the attained level and the grade it corresponds to is

meant to instill a feeling of self-worth and security in students and reduce their stress in the final section of the assessment.

The questions in the test are randomly chosen from a much larger question bank (a specific question can appear only once in one test). This introduces an element of randomness, allows replayability of the test, and, to some extent, prevents cheating in the classroom as the probability of two students sitting nearby receiving same questions at the same time is very low.

The students are constantly informed about their status, including their current level, life meter, the number of answered questions, and score. Every question is displayed with a counter displaying the time remaining to pick an answer.

The presented concept has been implemented in software. Its prototype implementation is described in the following section.

4. Software Implementation

The concept presented in section 3 has been implemented in a dedicated examination information system, provided as a web application. The application front-end was developed in HTML5, CSS3, and JavaScript with the jQuery 3.7.1 and Bootstrap 5.2.3 libraries. To implement the server-side, the Python programming language with the Django framework 5.0.1 was chosen. The software was developed according to the MVC design pattern. For server-side data storage, PostgreSQL has been chosen.

To participate in the test, the student follows an invitation link received from the teacher, which leads to the test landing page, showing a motivating image (selected by the teacher) and a textual introduction to the test. The test begins when the START button is clicked. At this moment, the first question page is presented (see Figure 1), containing: the title bar, the status pane (showing the question number, the student's points accumulated so far, the student's life meter, and the current level), the question content, the answer options, the buttons for invoking additional actions: option check and time extension (see section 3), and the answer approval button containing the counter for the remaining time (when it hits zero, the test moves on to the next question at the cost of the student losing 10% of their life); if no answer is selected, the button is labeled "I don't know" as it lets the student to skip the question at the cost of losing 10% of life instead of 15% for selecting a wrong answer.

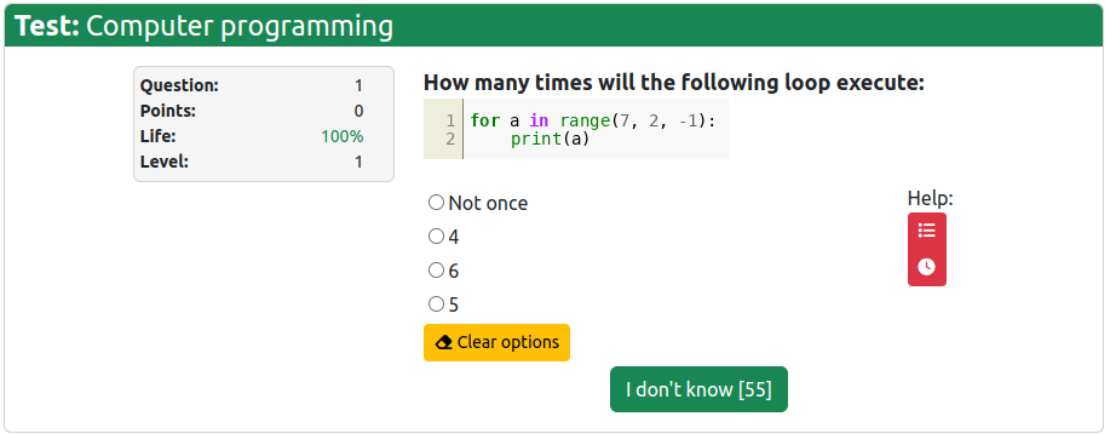

Fig. 1. Exemplary test question page.

After approving an answer (or when the time passes), the answer summary page is displayed. It may have one of two forms:

- success, displayed if the right answer has been selected (see Figure 2),
- failure, displayed if the right answer has not been selected (see Figure 3).

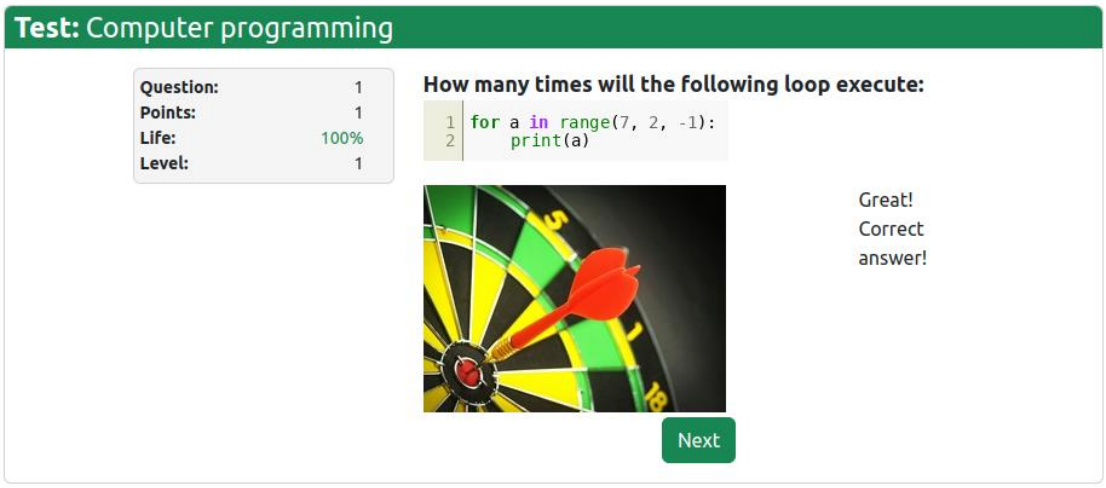

Fig. 2. Exemplary successful answer summary page.

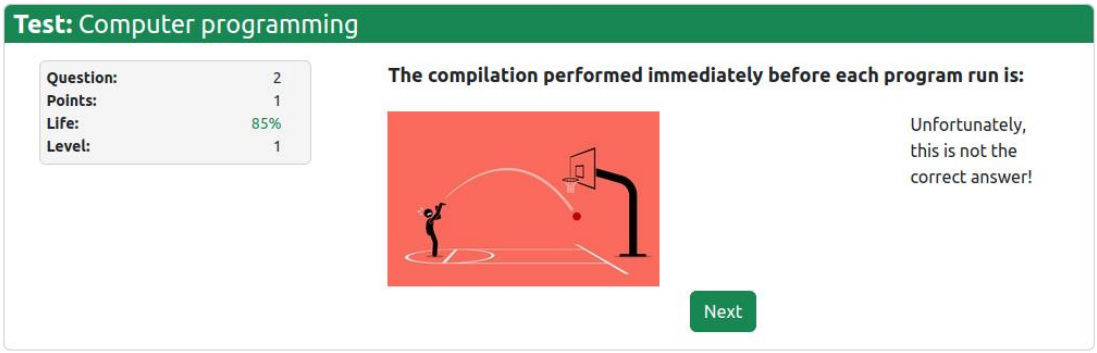

Fig. 3. Exemplary failed answer summary page.

After the student has completed the test, the test summary page is displayed (see Figure 4) with either a positive (test passed) or negative (test not passed) message. Note that a given test can only be taken once by a specific student: the students who reuse the invitation link to return to the test they have already tried see the test summary page.

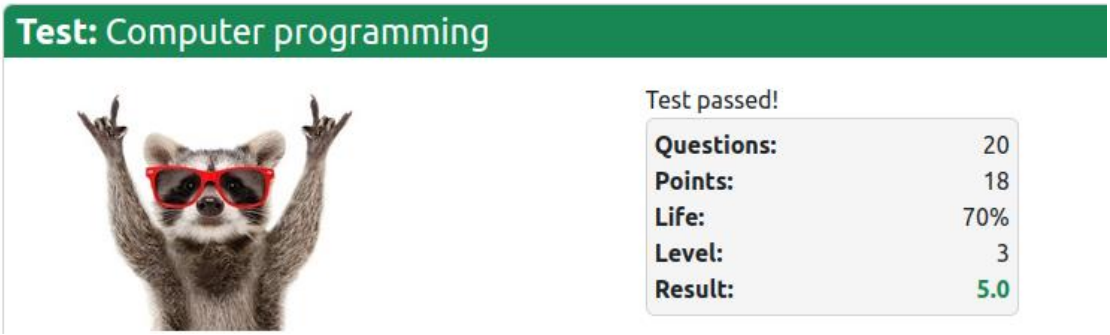

Fig. 4. Exemplary test summary page (test passed).

5. Evaluation

5.1. Evaluation Setting and Procedure

To evaluate the presented online assessment tool by students, a survey has been constructed containing 7 evaluation questions (see Table 2) plus detailed technical UI-related questions (aimed to identify potential flaws with the tool's layout, color scheme, and UI components' sizing) and demographic and context-defining questions (the grade obtained in the completed test, the course title, as well as student's gender and attitude towards computer and mobile games). The evaluation questions have been prepared by

the authors as to assess students' preference for the gamelike test over classic test forms considering four aspects important for educational gamification analysis (engagement, fun, stress, and ease) and their willingness to use it in three different assessment cases.

Table 2. Evaluation survey questions.

No.	Question
1	I felt more engaged than if I had written a classic test (on paper or in Moodle) [5-point Likert scale]
2	It was more fun than a classic test (on paper or in Moodle) [5-point Likert scale]
3	It was less stressful than a classic test (on paper or in Moodle) [5-point Likert scale]
4	It seemed easier to me than the classic test (on paper or in Moodle) [5-point Likert scale]
5	I would like to be able to independently test my knowledge of the subject in such a form [5-point Likert scale]
6	I would like to write tests during classes in such a form [5-point Likert scale]
7	I would like to write an exam/final credit test in such a form [5-point Likert scale]

The survey has been translated to the language of instruction and implemented in Microsoft Forms. The message displayed on the test summary page included information about the survey and the link to start it, so the students who decided to respond did it right after their test completion. The survey participation was anonymous and voluntary.

The survey has been performed on students attending two courses: Computer programming (4 groups) and Software testing (2 groups). Each group was first asked to do a test containing questions on their respective course subject. Altogether, the responses of 77 students were collected, including 56 males and 21 females. Over 79% of the respondents expressed a positive attitude toward video games, with only 8% expressing a negative attitude.

5.2. Evaluation Results

The histograms of responses to the questions listed in Table 2 are presented in Figure 5. As can be observed, among the main evaluation questions (the first three), the respondents reacted most positively to question 2 – receiving 68% of indications in the top range of 4 to 5, with the net difference between the shares of positive and negative answers of 52 percentage points (pp). This means most students do perceive the gamified assessment as more fun than a classic test (on paper or in Moodle). The second-best was the reaction to question 1 with 51% positive indications, and a net difference of 27 pp, meaning that the tool helped most students to become more engaged than they would be with a classic test. These two answers combined indicate that the goal for which the tool has been developed has been attained.

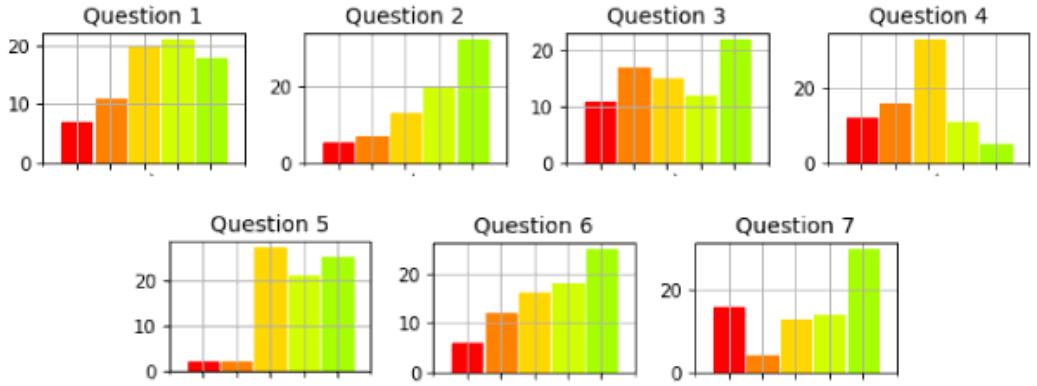

Fig. 5. Histograms of responses to the closed evaluation questions.

There were more students who perceived the gamified assessment as less stressful compared to a classic test (44%) than those who thought otherwise, though the margin was not large (net difference of 8 pp) (question 3). Regarding the students' perception of difficulty (question 4), only 21% of the respondents considered it easier than a classic

test, whereas 16 pp more of them thought the opposite. This result can also be linked to the fact that in the classic forms of assessment the students were familiar with, only the total test time was limited, and the students could return to questions skipped earlier.

As for the envisaged use of the tool, the majority of the surveyed students (60%, with only 5% declaring the opposite) would like to be able to use the tool on their own (i.e., for formative assessment) (question 5). While similar shares of the respondents would like to use the tool to write tests during classes (56%) and in the final exam (57%), the shares of respondents declaring the opposite was higher in this case (24% and 26% respectively) (questions 6-7). In Fig. 6, the results obtained from the male and non-male students are compared, revealing no large differences. The largest one (yet below 10%) regarded the fun factor (question 2), more often appreciated by males.

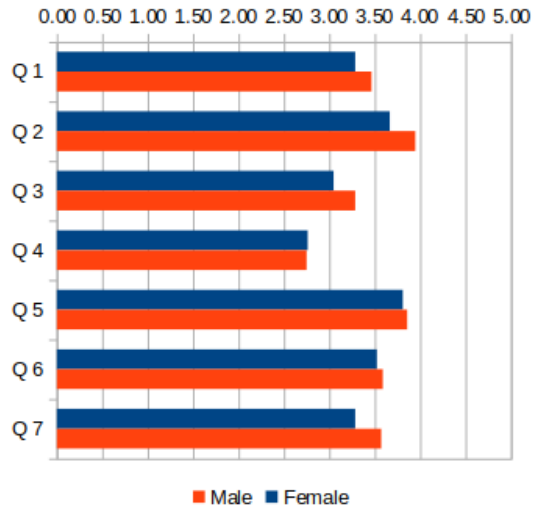

Fig. 6. Survey results by student's sex.

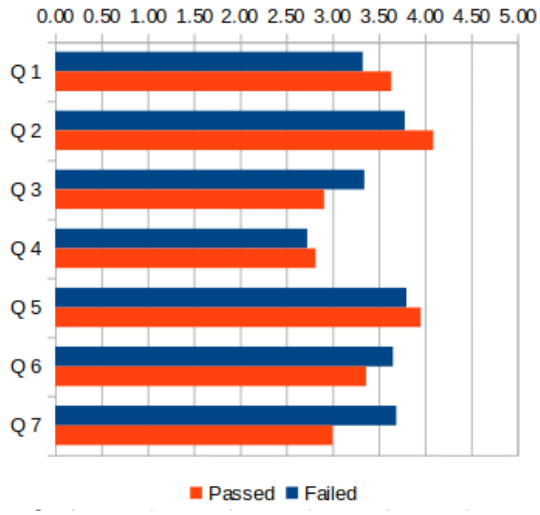

Fig. 7. Survey results by student's test result.

The differences between students who passed or failed the test are slightly higher, yet still small (see Figure 10). The largest one regarded question 7 and is difficult to explain as it is those who failed the test who more often accepted it as a form of the final exam.

6. Conclusion

Gamification is a flexible tool for bridging games and education. Online assessment is a convenient point of implementing gamification, however, the existing solutions implement its somewhat shallow form, based on a stiff selection of gamification mechanisms and focusing mostly on positive reinforcement, without the feeling of loss and failure, and thus far from an actual game-like experience. In this paper, we strive to address this gap by proposing a game-like online assessment tool and evaluating its prototype implementation.

Even though the presented game-like assessment capitalizes on the student's fear of failure, most of the surveyed not only found it to be more engaging and funnier, but also, though to a lesser extent, less stressful than a classic test (i.e., performed in Moodle or on paper). Most students would like to be assessed with the tool, even for important exams.

The study shares its limitations with other survey-based research based on non-representative samples, having reduced generalizability and reproducibility. Based on students' self-reporting, it is prone to subjective bias. Our future work is twofold. First, we would like to correct the tool's imperfections revealed in the survey and re-evaluate it on a larger scale. Second, we would like to investigate the effect of using the tool in formative assessment on students' learning in the long term, especially in comparison to the other existing gamified assessment tools.

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