

Tower of Questions: Gamified Testing to Engage Students in Peer Evaluation

Nafisul Kiron, Julita Vassileva
Computer Science Department
University of Saskatchewan, Canada
ni.kiron@usask.ca, julita.vassileva@usask.ca

Abstract. In recent years, the use of gamification in various software application areas is commonly used with success. Gamification is a technique of using game rules, designs and mechanics in non-game applications. Educational testing is an area that can benefit from this technique. It can help motivate, engage and encourage learners to participate in problem-solving and testing. In this research in progress, we propose a gamified peer-testing system called “The Tower of Questions”, in the form of a web-based tower defense game. Tower defense games are a subgenre of strategy games commonly found in computer, mobile, and console-based platforms. Our game is a question and answer game that the students will play with each other. Towers will be created and given to the students each time they ask questions. The students will then attack other students’ towers by answering those questions. This will continue until all the towers have either been defended or conquered. We believe this testing system will engage students in testing each other constructively and challengingly.

Keywords: Gamification, Peer-evaluation, Game-based testing

1 Introduction

The active participation of students in designing class test questions can make a more engaging learning environment [1]. Students who can keep pace with what the instructor is teaching in the class have a better understanding of the course materials and do better in the tests. Similarly, students, who can envision the questions the instructor may ask in the tests have a better knowledge about the key lessons of the course. Both types of students possess the ability to process their course studies thoroughly and come up with good class test questions. Course instructors sometimes engage students in making test questions and distributing these to the class to test each other [2]. The idea is to let the students submit the questions they find challenging. This creates scope for discussions and further learning of the course materials among the students and acts as a revision technique.

Having students actively participate in class activities can benefit the entire class. One way of achieving this is by gamifying the activities. Gamification means applying the elements of games, for example, rules, aesthetics, rewards etc. to non-game appli-

cations [3]. Gamification can make activities interesting by allowing students to compete, giving them status, achievements, self-expression, rewards etc. [4][5]. The course instructor can design the activities by adding game mechanics to the tasks by using a goal-oriented system. The gameplay experience of the players can be enhanced by providing them with long and short-term goals [6]. That is, by making the activities playful and rewarding, while all the points received from those activities will accumulate to something greater like securing a position in the leaderboard.

By using gamification in testing, students can be motivated to participate in a competitive learning environment. Letting students construct their own questions from the information they receive from the course gives them the freedom in designing questions from their own conceptual structures [1]. With the rules and rewards offered by the system, the students will be able to make plans on how they would want their games to end [6]. Having students test each other playfully will make them focus on the game-goals instead of thinking it as a class test. This will also create scope for discussions, learning the details, and preparation for future tests.

2 Literature Review

A number of studies on gamification in education have shown that it can engage people in various activities by imposing game rules, game aesthetics, rewards or a combination of all of these [5]–[9]. There are several successful educational and scientific services and applications utilizing gamification, for example, Khan Academy, treehouse, foldit, galaxy zoo etc. Most of the research done so far emphasized on engagement, data collection, behavioral outcomes and performance improvements by using game elements [6][9][10].

Yu et al. [1] introduced a web-based question posing system called QPPA (Question-Posing and Peer Assessment). This system allows students to construct, assess, review and practice answering questions [1]. There is a ranking list that shows the statistics of the students' performance. In another study, Yu [2] used multiple peer-assessment mode to increase question generation by students. The interaction between question authors and peers has been facilitated by a web-based system by allowing them to explain and negotiate each other's' feedbacks. Both studies focused on student-engagement and participation in generating questions.

In their study of a gamified assessment system, Kocadere and Çağlar [7] used the game dynamics, mechanics and components defined by Werbach and Hunter [11]. In their study, they found that 9 out of 11 participants preferred gamified assessment. They used game components such as question unlocking, points, leaderboard etc. in their assessment system to make it enjoyable and motivational. Attali et al. [12] studied the effect of points as a means of feedback in a gamified assessment. They performed the studies on adult and middle school participants. In their assessment, they considered the accuracy and speed of answering questions for awarding points for solving mathematical problems. They found that rewarding points might influence the efforts of the participants.

There are mixed results from studies regarding the effect of gamification on intrinsic motivation [12]. One research found that using game-like features to reward students for their performance might not be very effective in the long run and the effect of changing the incentives in the short run was inconclusive [12]. In another study where students found the peer-assessment system favorable, it was found that the sources of motivation might have come from a mixture of multiple factors like a sense of achievement, security, altruism, “challenging one’s own and other’s existing knowledge” etc. [1]. Kocadere and Çağlar [7] discussed both positive and negative aspects of gamified assessment grouped by themes (enjoyment, flow, motivation, learning, low anxiety, leaderboard and content unlocking). These studies were mostly focused on engagement for learning and assessment. Depending on the use of gamification and implementation of game-like motivational affordances the outcomes will vary from study to study [10]. Therefore, the use of gamification in testing for engaging students in a tower defense type peer-testing game is a solution we think is worth exploring.

3 Proposed System

3.1 Tower Defense Games

Our proposed system uses some game dynamics and mechanics from tower defense games, which are a subgenre of strategy games [13][14]. There are many variations and versions of this genre, but the basic rule is the same. In a tower defense game, players defend their towers from enemy attacks. Enemies attack the tower to conquer it. In our game, the questions asked by the players will create virtual towers, and by answering the questions other players will attack it. At the beginning of the game, players ask questions to create towers, for each question asked one tower will be created. In regular tower defense games, the tower has a health-bar that shows how many attacks it can receive before breaking down. In our case, the tower can be conquered by attacking it with the correct answer. During the gameplay, the players get gems for creating new towers and by conquering other player’s towers. The leaderboard will be based on the number of gems the players earned throughout the gameplay. There is a time limit for attacking the towers after which those towers will be considered safe and cannot be attacked. However, the closer the deadline is the more damage the towers will take and the amount of reward gems will be increased accordingly.

3.2 Design and Method

“The Tower of Questions” will be a web-based game. The game mechanics are similar to that of a real tower defense game. The players and enemies are students from the class. The players use the game to post questions based on their course topics. Each student can ask multiple questions from the available question types. The question can be true-false, MCQ (Multiple choice questions) or in short answer form. Each question

posted in the game will act like a tower. The other students in the class will try to attack that tower by answering it.

At the beginning of the game, the course instructor will set the number of gems available for the game. Players can earn gems by asking questions and by answering other players' questions. Throughout the entire gameplay, the number of gems earned by the players will not exceed the amount of gems set by the instructor at the beginning of the game. Each question asked by the players will deduct a fixed amount of gems from the main reserve. The main reserve is the place where all the un-earned gems are stored. If there are no gems left in the reserve, no further questions can be asked by the players. However, the instructor may increase or decrease the amount of total gems in the reserve and let the game proceed or end.

Once a student asks a question, a tower will be created virtually in the game for that question. The player who asked the question is the Lord of that tower. Then the tower will be made visible to other players. That tower will then be available for a fixed period of time to other players to attack it by answering the question. Each player can attack each tower of other players only once. During the time of the attack, other players cannot attack it. The attack consists by the attacker submitting an answer to the question, the answer is shown to the Lord of that tower for review. When reviewing the answer, the Lord will mark it correct, incorrect or partially correct. This concludes the attack. Until the Lord has marked the answer, no other players can attempt an attack on the tower by answering it. After the Lord has marked an answer fully or partially correct, that question and answer will be made publicly visible and cannot be attacked again. If it is correct, the attacker will receive a portion of the gems awarded for the creation of the tower, otherwise, the Lord keeps the gems. Each player can give partial marks up to three times, after which they have to award full marks. That means that only 3 different attackers can give partially correct answers, after that every next attempt would be marked as either "right" or "wrong". If the answer was wrong, the tower will be open for attacks again. However, if the question was not successfully answered within the fixed period, the Lord will have to answer it and then it will be made visible to public and the tower will be considered safe from all attacks. In this case, the Lord keeps the gems earned by creating the tower.

The players will continue to add new towers by asking questions and attack other player's towers by answering until all the questions have been answered, all the available gems have been earned or all the question deadlines have been reached. After that, the course instructor monitors the status of the game and the current leaderboard. During the entire gameplay, the game is moderated by assistants assigned by the course instructor. Players can report low quality or spam questions and unfairness in marking during the gameplay. The moderators will keep a watch on reported issues and keep the gameplay stable. For example, they review the leaderboard and especially the top achievers – were their questions well formulated? Did they actually have an answer? After a human review, the final leaderboard is posted. Fig. 1 illustrates a flowchart of the processes.

An example walkthrough of the game is as follows:

- A player called Lord-X posts 15 unique questions of several types in the game, thus 15 towers are created. For each question, Lord-X receives 10 gems. So, for the 15 questions, Lord-X earns 150 gems.
- The players can post as many questions as they want while there are enough gems available in the reserve. For example, there are 500 gems left in the reserve and Lord-X asked 15 questions in the game. So, Lord-X will earn 150 gems and the remaining gems in the reserve will be 350. Similarly, player Lord-Y and Lord-Z ask 15 and 19 questions respectively. Therefore, they earn 150 and 190 gems respectively and the number of remaining gems in the reserve becomes 10.
- Now that the players have some towers, they start attacking each other. Lord-X successfully attacks Lord-Y's tower by answering a true-false question. So, he receives 6 out of the 10 gems from that tower. The remaining 4 gems are for Lord-Y to keep for his contribution in building that tower. The distribution of gems for true-false and MCQ type questions are the same.

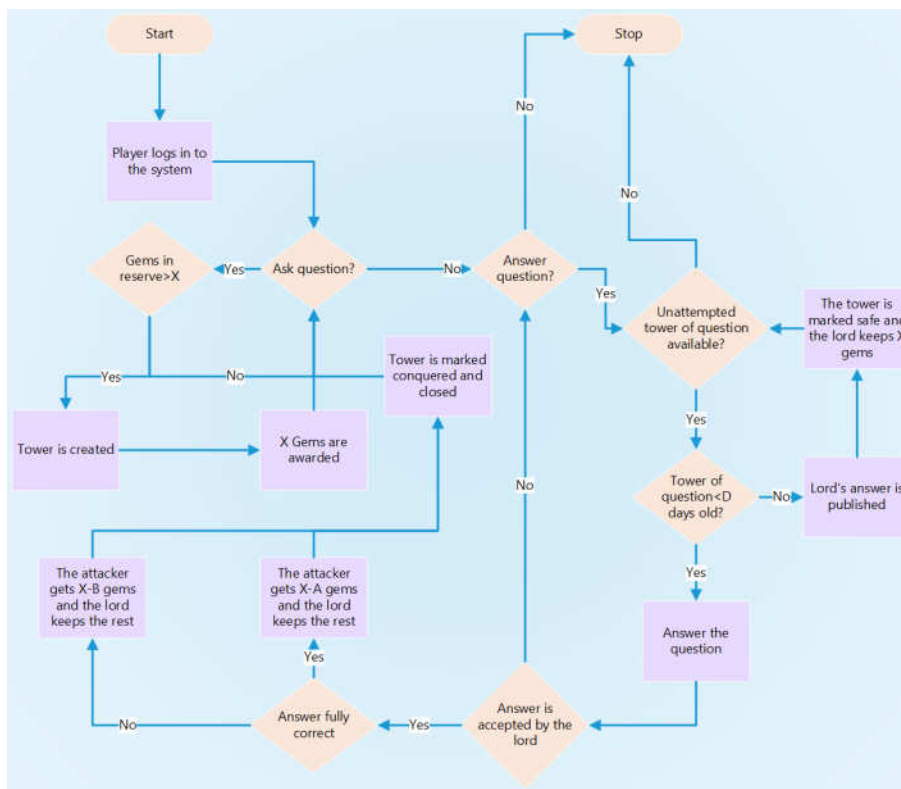


Fig. 1. Flowchart of the game. The variables A, B, X and D are set by the course instructor.

- Then, Lord-Y attacks Lord-Z's tower with a short answer. Lord-Z found the answer to be partially correct. So, he marks it partially correct and publishes the Lord's and attacker's answer in the system. Lord-Y receives 4 and Lord-Z keeps the remaining

6 gems for that tower. The system allows the players to partially award gems to the attacker up to the number of times allowed by the teacher. For example, the system allows each player to award partial gems up to 3 times. So, the player can award partial gems for 3 towers that have partially correct answers. After that, they will have to give full marks.

- The players keep on attacking each other's tower and in the end, only a few towers are left. The reserve still has 10 gems from the original 500. Lord-X, Lord-Y, and Lord-Z each hold 146, 164 and 180 gems respectively. Lord-Y decides to ask another question, and this uses up the remaining 10 gems from the reserve. Lord-Y's new score is 174 gems. Lord-Z tries to post another question but fails because there are no gems left in the reserve.
- With what is left, they attack each other for the last stand and eventually must stop. Each of them defends a few towers completely because no one has answered those questions. So, the Lord's answer for those questions is published publicly. Since these towers are untouched, the Lords of these towers keeps the full 10 gems for each untouched tower.
- Finally, before the course instructor publishes the final leaderboard a final check for all reported question and answers are reviewed by the moderators. The moderators are actively monitoring the game throughout the entire session. They investigate situations which the players report as unfair.

4 Conclusion and Future Work

In this paper, we propose a gamified web-based game to motivate students to participate in a question and answer posing system, masked as a tower defense game. The game will allow students to test each other using the asynchronous web-based system. By rewarding gems for submitting test questions and defending the towers, we are expecting students to post high-quality questions to better defend their position in the game. The game supports learning since it requires students to think of good questions about the material themselves, which is an important aspect of active learning; it does in a playful context, and allows students to test each other in a game that, we believe, will motivate them to learn the material better and perform well in real exams.

Our future plan is to test the system with students at the University of Saskatchewan. We will evaluate the interactions within the system by counting the number of banked gems among the students and the number of questions and answers. We will evaluate separately the quality of the questions generated and the good questions will become part of the test-item bank for the class (a useful byproduct of the game). Finally, a post gameplay survey will be presented to the students to learn their level of satisfaction in using the system. We will measure the student engagement through their participation and satisfaction. We will also measure student achievement through the scores in the game, counting both the scores earned by creating questions and by answering them. We will attempt to correlate these scores with those obtained at mid-term and final exams and we expect to find positive significant positive correlations.

References

- [1] F. Y. Yu, Y. H. Liu, and T. W. Chan, "A web-based learning system for question-posing and peer assessment," *Innov. Educ. Teach. Int.*, vol. 42, no. 4, pp. 337–348, 2005.
- [2] F. Y. Yu, "Multiple peer-assessment modes to augment online student question-generation processes," *Comput. Educ.*, vol. 56, no. 2, pp. 484–494, 2011.
- [3] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From game design elements to gamefulness," *Proc. 15th Int. Acad. MindTrek Conf. Envisioning Futur. Media Environ. - MindTrek '11*, no. September, p. 9, 2011.
- [4] Bunchball, "Gamification 101 : An Introduction to the Use of Game Dynamics to Influence Behavior," no. October, 2010.
- [5] C. C. I. Muntean, "Raising engagement in e-learning through gamification," *6th Int. Conf. Virtual Learn. ICVL 2011*, no. 1, pp. 323–329, 2011.
- [6] F. F. Nah, V. R. Telaprolu, S. Rallapalli, and P. R. Venkata, "Gamification of Education Using Computer Games," vol. 8018, no. July 2013, 2013.
- [7] S. A. Kocadere and Ş. Çağlar, "The design and implementation of a gamified assessment," *J. E-Learning Knowl. Soc.*, vol. 11, no. 3, pp. 85–99, 2015.
- [8] B. B. Morrison and B. DiSalvo, "Khan academy gamifies computer science," *Proc. 45th ACM Tech. Symp. Comput. Sci. Educ. - SIGCSE '14*, pp. 39–44, 2014.
- [9] P. Łupkowski and P. Wietrzycka, "Gamification for Question Processing Research – the QuestGen Game," vol. 1, no. 7.
- [10] J. Hamari, J. Koivisto, and H. Sarsa, "Does gamification work? - A literature review of empirical studies on gamification," *Proc. Annu. Hawaii Int. Conf. Syst. Sci.*, pp. 3025–3034, 2014.
- [11] K. Werbach and D. Hunter, *For the Win: How Game Thinking Can Revolutionize Your Business*. Wharton Digital Press, 2012.
- [12] Y. Attali and M. Arieli-Attali, "Gamification in assessment: Do points affect test performance?," *Comput. Educ.*, vol. 83, pp. 57–63, 2015.
- [13] "Tower Defense games on Kongregate." [Online]. Available: <https://www.kongregate.com/tower-defense-games>. [Accessed: 21-Mar-2018].
- [14] P. Avery, J. Togelius, E. Alistar, and R. P. Van Leeuwen, "Computational intelligence and tower defence games," *2011 IEEE Congr. Evol. Comput. CEC 2011*, pp. 1084–1091, 2011.